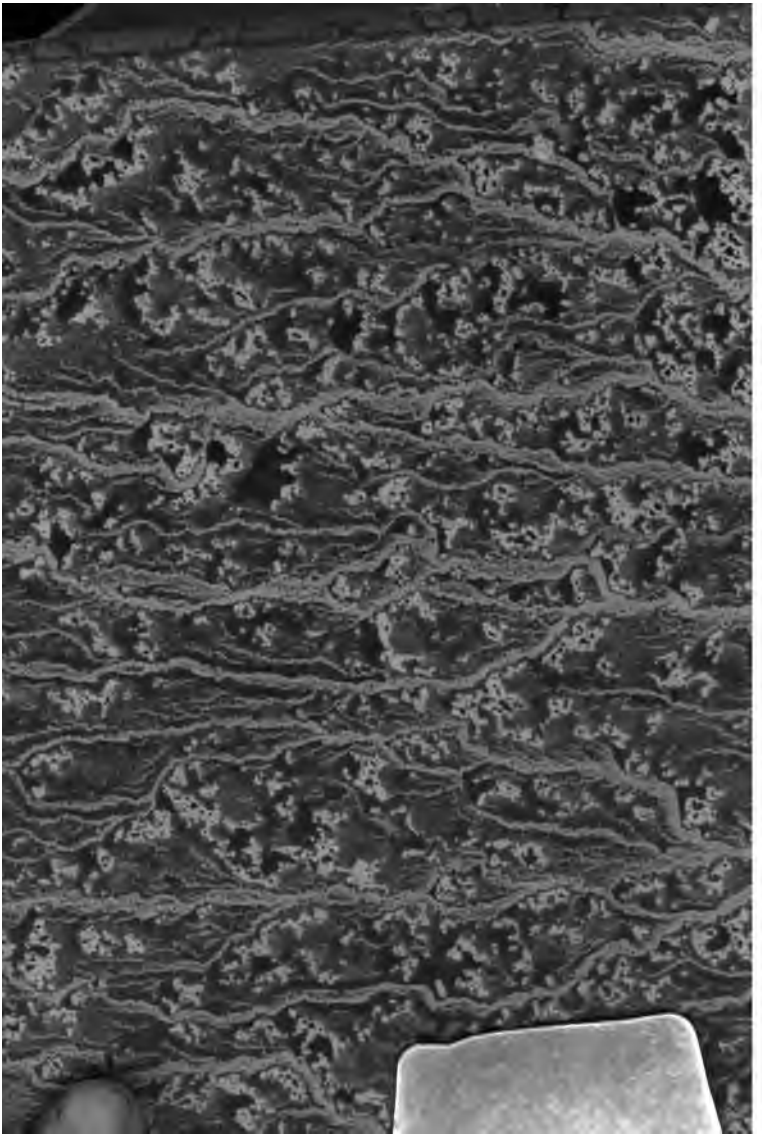
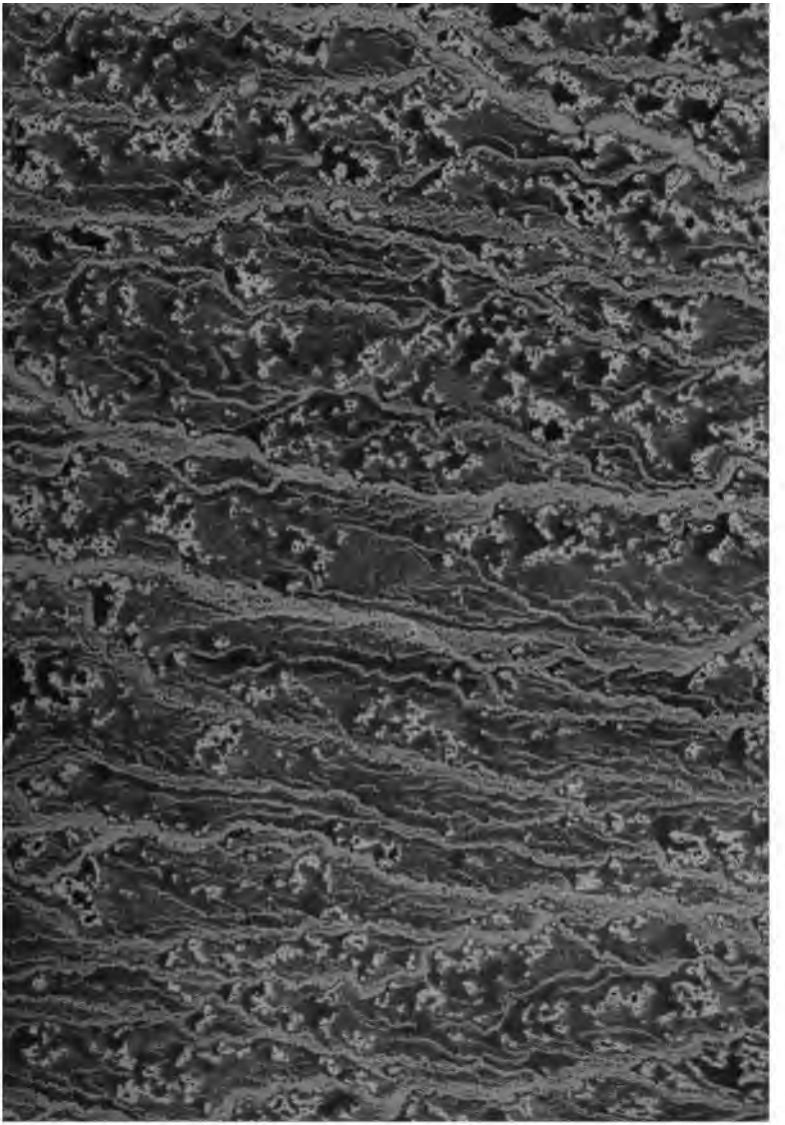
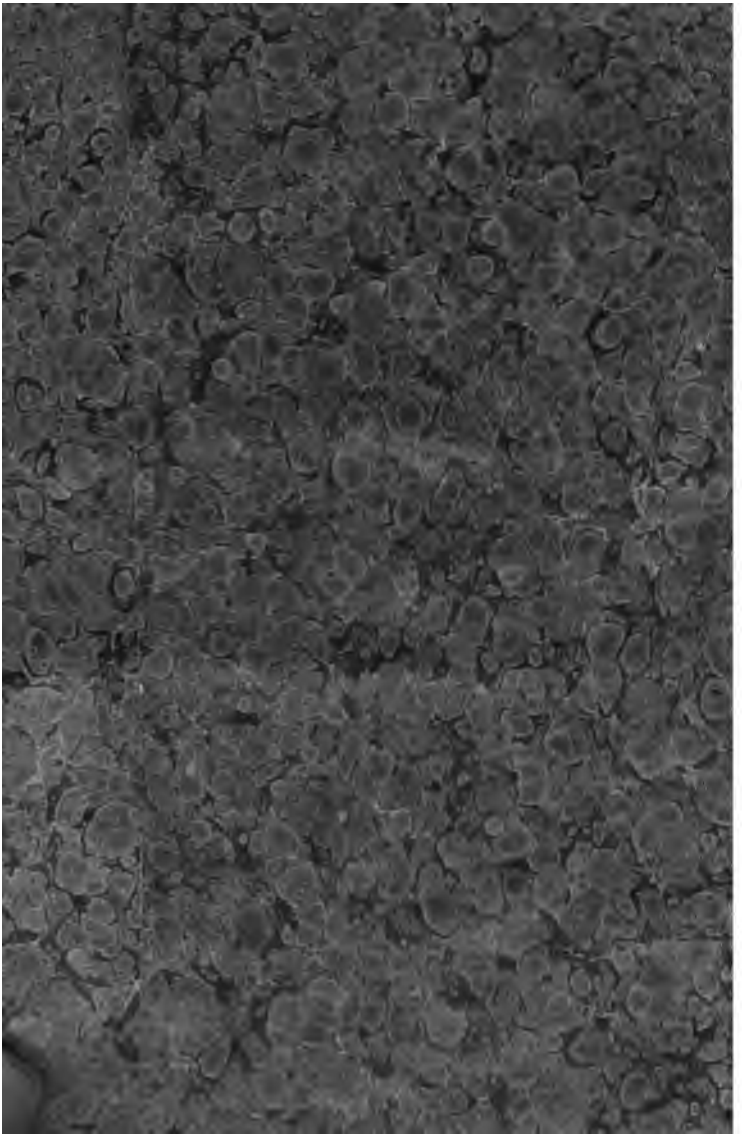
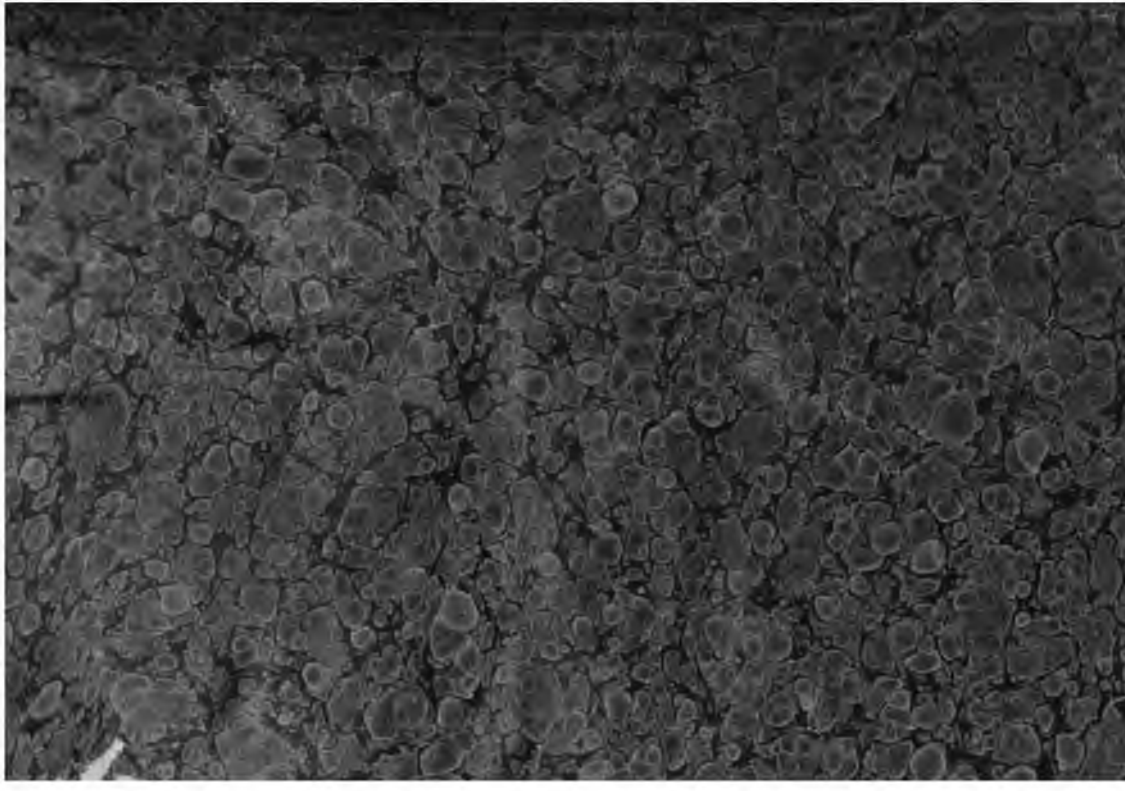








THE GUNNER'S ASSISTANT,

COMPILED AT THE

Madras Artillery Depot of Instruction,

ARTILLERY HEAD QUARTERS

MAJOR A. F. OAKES.

6th Edition, Revised and Enlarged.

ARTILLERY DEPOT PRESS, ST. THOMAS' MOUNT,

LUCAS D'ROZARIO, PRINTER.

1857.

Madras Artillery { MORTARS. } Depot, Mount

		IRON.			BRASS.	
		13 Inch.	10 Inch.	8 Inch.	5⅘ Inch.	4⅘ Inch.
Weight of	Mortar.....Cwt.	35-3-11	16-1-11	8-1-4	1-3- 0	0-3-19
	Bed..... „	50-3- 7	22-2-0	12-1-0	1-1-20	0-3-10
Length of	Mortar.....Ins.	39·5	28·	22·5	17·	13·
	Bore*..... „	26·	20·	16·	13·	10·8
	Chamber..... „	13·	10·	8·	5·2	3·8
Diameter of	Bore..... „	13·	10·	8·	5·66 (a)	4·52
	Chamber Superior.. „	13·	10·	8·	2·8	2·25
	Chamber Inferior.. „	6·5	5·	4·	2·	1·75
Gauges.	High..... „	12·88	9·88	7·90	5·62	4·47
	Low..... „	12·80	9·80	7·82	5·57	4·43
Shells	Diameter..... „	12·84	9·84	7·86	5·59 (b)	4·45 (b)
	Weight of (average) Empty...lbs.	196	87	44	16-4	8-3
	Weight of (average) Filled.... „	203	90	46	17	8-8
	Thickness.....Ins.	2·	1·6	1·3	0·85	0·7
Carcasses	Weight of Empty.....lbs.	195	90-4	46	15-6	8-6
	Weight of Filled..... „	224	103-8	51-8	16-9½	8-13
	Thickness.....Ins.	2·3	2·3	1·6	0·95	0·75
Fire Balls	Weight of Empty .....lbs.	18	7 2	4	1-8	0-9
	Weight of Filled..... „	38	19	9-8	3-4	1-12
	Thickness.....Ins.	1·6	1·4	1·1	·75	·60
Gun-powder.	Proof of Mortar.....lbs.	9	4	2	0-10	0-5
	Proof of Bouched Ord. „	4½	2	1	0-5	0-2½
	Proof of Bed..... „	9	4	2	0-6¾	0-3¾
	Chamber contains.... „	9	4	2	0-10	0-5
	Bursting Shells..... „	6-12	2-10	1-14	0-10	0-5
	Starting Fuzes.....oz.	4	3	2-8	1-4	1-0
	Scaling..... „	4	3	2-8	1-4	1-0
Fuzes.	Length.....Ins.	5·	5·	5·	4·	3·
	Time of burning.....Sec.	25	25	25	20	15
Diameter of Vent.....Ins.		⅜	⅜	⅜	⅜	⅜
Windage..... „		·16	·16	·14	·07	·07
Greatest Range at 45°.....yards.		2706	2536	1720	1500	1000
Diameter of bore, unserviceable (c).Ins.		13·05	10·05	8·05	5·70	4·56
„ Shell „ .... „		12·75	9·75	7·80	5·54	4·40

* Including Chamber.

(a) Old Madras Conical 5·62.
(b) *New Shells.*
(c) *Military Board's* Circular Order No. LIII. of 1856.

Mortar Ranges at 45 Degrees. Proof Range of Powder 728 yards with 8 Inch Eprouvette, Charge 1 lb.

Ranges.	Fuze.		13 Inch.			10 Inch.			8 Inch.			5½ In. *		4⅝ In. *	
	Ins.	ths.	lbs.	ozs.	drs.	lbs.	ozs.	drs.	lbs.	ozs.	drs.	ozs.	drs.	ozs.	drs.
300	1	5	1	7	..	..	13	7	..	8	13	2	4	1	7
350	1	6	1	9	11	..	14	13	..	9	11	2	6	1	9
400	1	7	1	12	4	1	..	3	..	10	9	2	9	1	11
450	1	8	1	14	11	1	1	9	..	11	8	2	12	1	13
500	1	9⅝	2	1	..	1	3	..	..	12	6	2	15	1	15
550	2	0⅛	2	3	7	1	4	6	..	13	5	3	2	2	1
600	2	1⅝	2	5	13	1	5	12	..	14	1	3	5	2	3
650	2	2	2	8	3	1	7	2	..	15	..	3	8	2	6
700	2	3⅛	2	10	10	1	8	8	..	15	13	3	11	2	9
750	2	4	2	13	4	1	9	14	1	..	12	3	14	..	..
800	2	4⅛	2	15	12	1	11	4	1	1	9	4	1	..	..
850	2	5⅛	3	2	5	1	12	10	1	2	7	4	4	..	..
900	2	6	3	4	12	1	13	15	1	3	5	4	7	..	..
950	2	7	3	7	3	1	15	7	1	4	4	4	10	..	..
1000	2	8	3	9	11	2	..	13	1	5	2	4	13	..	..
1050	2	9	3	12	..	2	2	3	1	6	..	5	0	..	..
1100	2	9½	3	14	10	2	3	9	1	6	13	5	4	..	..
1150	3	..	4	1	7	2	4	14	1	7	10	5	7	..	..
1200	3	0⅛	4	3	15	2	6	5	1	8	7	5	11	..	..
1300	3	1⅛	4	9	..	2	9	..	1	10	..	..	..	..	..
1400	3	3	4	14	..	2	11	..	1	11	10	..	..	..	..
1500	3	4	5	3	..	2	14	..	1	13	4	..	..	..	..
1600	3	5	5	8	8	3	1	5	1	14	12	..	..	..	..
1700	3	6	5	14	..	3	4	1	2	..	..	..	..	..	..

Distance from the Revetment for Mortars at the following Elevations. Revetment 8 feet high.

Elevation.	45°	30°	20°	15°	10°
Distances.....	12 feet	18 feet	21 feet	30 feet	40 feet

Mortars are placed 15 feet from centre to centre of each other.

To find the time of flight, the range being given at 45°. Divide the square root of the given range in feet by 4 for the time of flight in seconds.

To find the range, time of flight being given at 45°. Multiply the time of flight in seconds by 4 and square the product for the range in feet.

Mortar Platforms.

The traversing platform (Bombay pattern) consists of three sleepers, and an upper frame, the front sleeper having a bolt passing through it from underneath, on which the frame is traversed. Weight lbs. 890—Slope 1 inch per foot.

Colonel Derville's (improved by Captain Oakes,) consists of 5 sleepers (the two outer and the centre sleeper having 9 bolts passing through each from underneath) 9 planks, 2 Ribands, 6 square and 9 circular nuts, Weight lbs. 1302. Laid horizontal.

Table of Shells Ranges in yards, and Time of flight at 45° of Elevation, taken from a medium of 5 years practice at Saint Thomas' Mount.

Seconds.	Yards.	Seconds.	Yards.
5½	173	12	747
6	207	12½	805
6½	246	13	877
7	267	13½	920
7½	314	14	998
8	349	14½	1053
8½	389	15	1136
9	414	15½	1211
9½	467	16	1252
10	523	16½	1345
10½	566	17	1423
11	629	17½	1540
11½	667	..	..

* Mortars 5½ and 4⅝ Inch **Conical** Chamber, and new Shell.—With 5½ inch old Shells add *12 drs. to the above charges* up to 400 yards, and 1 oz. from 400 upwards.

RANGES WITH 5½ INCH CONICAL CHAMBERED MORTARS FROM ACTUAL PRACTICE IN 1854.*

Charge.	10°			20°			30°			40°		
	Fuze.		Distance	Fuze.		Distance	Fuze.		Distance	Fuze.		Dist.
ozs.	Ins.	ths.	Yards.	Ins.	ths.	Yards.	Ins.	ths.	Yards.	Ins.	ths.	Yards.
2	..	4	81	..	6	164	1	0	216	1	2	266
3	..	5	180	..	8	354	1	4	479	1	7	496
4	..	7	298	..	9	549	1	8	679	2	1	722
5	..	8	423	1	0	657	2	0	898	2	4	980
6	..	9	511	1	6	776	2	4	1079	2	8	1199

Charge.	50°			60°			70°			80°		
	Fuze.		Distance	Fuze.		Distance	Fuze.		Distance	Fuze.		Dist.
ozs.	Ins.	ths.	Yards.	Ins.	ths.	Yards.	Ins.	ths.	Yards.	Ins.	ths.	Yards.
2	1	4	247	1	5	237	1	8	166	2	0	100
3	1	9	518	2	2	452	2	4	326	2	8	180
4	2	5	751	2	8	652	3	0	491	3	4	257
5	2	8	990	3	0	855	3	2	657	4	4	319
6	3	4	1294	3	7	1093	4	0	769	4	8	404

RANGES WITH 5½ INCH BENGAL GOMER CHAMBERED MORTAR.

Charge.	15°			25°			45°			The approximate average ranges obtained with the Gomer compared with the Conical Chamber are, for 2 oz. ⅛, 4 oz. ⅜, 6 oz. ½, 8 oz. ⅝, and 10 oz. ⅝.
	Fuze.		Distance	Fuze.		Distance	Fuze.		Distance	
ozs.	Ins.	ths.	Yards.	Ins.	ths.	Yards.	Ins.	ths.	Yards.	
2	..	4	71	..	6	112	..	9	121	
4	..	6	162	..	8½	231	1	4	251	
6	..	8	311	1	2	455	2	½	540	
8	1	..	521	1	8	747	2	6½	837	
10	1	2	722	2	1	969	3	1	1052	

RANGES WITH 4⅘ INCH CONICAL CHAMBERED MORTARS, FROM ACTU[AL] PRACTICE AT TRICHINOPOLY IN 1856.

Charge.	10°			20°			30°			40°		
	Fuze.		Distance	Fuze.		Distance	Fuze.		Distance	Fuze.		Dist.
ozs.	Ins.	ths.	Yards.	Ins.	ths.	Yards.	Ins.	ths.	Yards.	Ins.	ths.	Yards.
2	..	4½	159	..	8	260	1	3½	452	1	7½	474
3	..	8	391	1	3	570	1	9	810	2	4	856
4	1	..	540	1	5	793	2	2½	1074	2	7½	1146

* New 5½ *Inch Shells*—proof range of Gunpowder with 8 Inch Eprouvette, 1 lb. charge, *723 yards.*

Madras Artillery { GARRISON ORDNANCE. } Depot, Mount.

			12 Inch.	10 Inch.	8 Inch.	68 Pdr.	56 Pdr.	42 Pdr.	32 Pdr.
Weight of	Gun	Cwts.	90	85	65	95	98	67	56
	Carriage wooden	,,	17-2	13-2	13-2	15	15-2	16-3	15-1
	Total	,,	107-2	98-2	78-2	110	113-2	83-3	71-1
Length of	Gun	Feet.	8-4	9-4	9	10	11	9-6	9-6
	Bore*	Ins.	...	109·33	105·27	111·075	124·89	108·73	107·2
	Chamber	,,	16·	11·83	13·44	...	...	...	...
Diameter of	Bore	,,	12·	10·	8·05	8·12	7·65	6·935	6·41
	Chamber, Superior	,,	12·	10·	8·05	...	...	...	...
	Chamber, Inferior	,,	...	7·3	5·8	...	...	...	...
Gauges	High	,,	11·88	9·88	7·95	7·95	7·51	6·795	6·207
	Low	,,	11·8	9·8	7·9	7·9	7·45	6·729	6·147
Shot. Canister	Balls weight	oz.	...	16	8 or 16	8 or 16	8 or 16	[illegible]	·4
	,, in each	No.	...	34	90or45	90 or 45	78or39	85	132
	Total weight	lbs.	...	82	53	53	48	46	35½
Shot. Weight	Hollow	,,	112	84	56& 48	...	...	...	...
	Solid	,,	230	130	60	66½	55 1/16	41½	31½
	Shell empty	,,	112	82	48	48	...	...	...
	Diameter of	Ins.	11·84	9·84	7·925	7·926	7·48	6·765	6·177
Gunpowder Proof of	Gun	lbs.	18	18	20	30	28	25	21½
	Bouched Ordnance	,,	12	12	10	10	16	14	10
	Carriage	,,	12	12	10	10	16	14	10
Gunpowder Service Charge		,,	12	12	*10	10	16	14	10
Gunpowder Scaling		,,	3	3	2½	2½	4	3½	2¾
Gunpowder Bursting Shell		,,	12	6·8	2	2	...	...	...
Proportion between Shot and Gun	Hollow	,,	†90	112	136	...	...	...	...
	Solid	,,	†43	72	107	160	194	180	199
Diameter of Bore unserviceable		Ins.	12·05	10·05	8·1	8·17	7·7	6·985	6·46
,, ,, Shot	,,	,,	‡	‡	7·80	‡	‡	6·68	6·10
Windage		,,	·16	·16	·125	·195	·17	·17	·233
Preponderance of Breech		Cwt.	...	9	7-3-7	10-2-4	10-1-4	6-2-7	5-0-11
Tangent of 1°		Ins.	1·745	1·954	1·885	2·095	2·304	1·998	1·989
Dispart		Ins.	...	1·91	1·85	2·04	2·3	1·94	1·94
		Deg.	...	2·25	2·0	2·25	2 25	2·0	2·5

The dispart of a piece of Ordnance is half the difference of the diameters at the base ring, and at the swell of the muzzle. The angle of dispart is the angle formed by the line of metal, and another line parallel to the axis. The dispart in iron guns is equivalent to, from 1½ degree to 2½ degrees; in Light Field Guns about 1 degree.

By experiment at a mean range, it has been ascertained that in common earth, dug up and well rammed, **a musket ball buries itself nearly** 1½ foot, **a 6 Pdr.** from 3½ to 4½ feet, **9 Pdr.** from 6½ to 7 feet, **12 Pdr.** from 8½ to 10 feet, **18** and **24 Pdr.** from 11½ to 13 feet.

To find the tangent of 1 degree for every nature of Ordnance.—Multiply the length of the gun in inches by ·017455 for the length of tangent for 1° of elevation, from this product subtract the dispart, and the length of tangent scale above the base ring for 1° of elevation will be obtained.

* With 48 lbs. hollow shot 8 lbs; and with the 56 lbs. hollow shot 9 lbs.
† Taking the shot as 1. ‡ Distinguished by Low Gauge.

* Including Chamber.

Madras Artillery { FIELD GUNS. } Depot, Mount.

		IRON.			BRASS.		
		24 Pdr.	18 Pdr.	12 Pdr.	9 Pdr.	6 Pdr.	3 Pdr.
Weight of	Gun.....Cwt.	50	42	34	10	6	3
	Carriage..... „	25	25	23	10-3-16	9-2-18	8-1
	Limber..... „	15	15	15	10-0-0	10-0-0	7-2
	Total..... „	90	82	72	30-3-16	25-2-18	18-3
Diameter of Bore.....Ins.		5·823	5·292	4·623	4·2	3·668	2·91
Length of	Gun.....Feet.	9-6	9	9	5-8·5	5	4
	Bore.....Ins.	107·41	101·75	102·23	65·75	57·47	46·
Shot. Canister.	Balls weight.....ozs.	4	4	4	4	4	4
	„ in each.....No.	92	78	50	40	25	12
	Total weight.....lbs.	25-8	21-10	14	11-0	7	3-6
Shot. Spherical Case.	Thickness.....Ins.	·6	·5	·45	·4	·3	·3
	No. of Musket Balls in each.	130	90	63	41	27	11
	Weight empty.....lbs.	11	8-4	5-12	4-8	3	1-8
	„ filled..... „	20-6	14-12-5	10-6	7-8-12	5-0-4	2-56
	Weight of Round Shot... „	23-8	17-8	11-11	8-11	5-10	2-14
	Diameter of „ ..Ins.	5·611	5·099	4·454	4·1	3·567	2·823
Gauges.	High.....Ins.	5·639	5·124	4·476	4·1	3·568	2·833
	Low..... „	5·584	5·074	4·432	4·06	3·533	2·803
Gunpowder. Proof of	Gun.....lbs.	18	15	12	3	2	1-8
	Bouched Ordnance.... „	8	6	4	2-4	1-8	0-12
	Carriage..... „	8	6	4	2-4	1-8	0-12
	Service Charge..... „	8	6	4	2-4	1-8	0-12
	Saluting..... „	6	4-8	3	1-12	1-4	0-
	Scaling..... „	2	1-8	0-12	0-8	0-4	0-
	Bursting S. C. Shot...ozs.	6	5	4½	3½	2½	1½
Rounds carried with each Gun.	Round Shot.....	1000	1000	1000	88	144	200
	Common Shell.....	100	100	100	..	..	..
	Canister.....	100	100	100	16	18	56
	Spherical Case.....	100	100	100	24	32	0
	Total.....	1300	1300	1300	128	194	256
Proportion between Shot and Gun..lbs.		*233	261	308	124	112	112
Diameter of Vent.....Ins.		5/16	5/16	5/16	3/16	3/16	3/16
Diameter of Bore, unserviceable.. „		5·873	5·342	4·673	4·24	3·708	2·95
„ „ Shot „ .. „		5·54	5·04	4·40	4·	3·49	2·77
Windage..... „		·212	·193	·169	·1	·101	0·87
Preponderance of Breech.....Cwt.		4-2	3-2-14	3-2-0	0-3-4	0-2-0	0-1-5
Tangent of 1°.....Ins		1·989	1·885	1·885	1·196	1·047	·837
Dispart.....	Ins.	1·95	1 85	1·85	1·32	1·02	·73
	Deg	1·5	1·5	1·5	1·09	·97	·87

The Madras traversing Gun platform consists of 3 sleepers, 2 hurters, 1 centre or receiling plank, 2 wheel planks, 2 cross planks, 1 pintrail and 8 bolts with keys and washers. Total weight lbs. 1190. Slope 1 inch per foot.

Gun platform of Colonel Derville's (improved by Captain Oakes) is made of 2 of the Mortar platforms described in page 4, the sleepers being joined by means of horizontal screw bolts. Total weight lbs. 2604. Slope 1 inch per foot.

* Taking the shot as 1,

Nature.	Shot. lbs.	Charge lbs.	Ranges in yards at P B	1°	2°	3°	4°	5°	6°	8°	10°	12°	Above Plane. ft.	ins.
12 Inch.....	H. S. 112	12	240	540	790	1020	1250	1400	1550	...	...	...	...	...
10 ,, ...	H. S. 86	12	310	620	900	1160	1410	1640	1800	2090	2300	2490	5	...
8 ,, ...	H. S. 56	10	340	740	1100	1410	1700	1930	2100	2410	2700	2950	8	...
8 ,, ...	H. S. 48	8	450	791	1132	1342	1552	1762	1972	2351	2687	3023	...	...
68 Pounder..	S. S. 66½	15	310	700	1070	1430	1710	1930	2130	2520	2890	3180	5	4
68 ,, ...	Shell 56	16	350	850	1250	1560	1840	2160	2350	2690	3000	3300	5	4
56 ,, ...	S. S. 55 1/16	16	490	930	1340	1720	2000	2200	2400	2740	3040	3320	5	4
42 ,, ...	S. S. 41⅛	14	400	940	1340	1620	1840	2050	2250	2590	2900	3200	6	...
32 ,, ...	S. S. 31¼	10	370	778	1160	1460	1690	1910	2110	2460	2760	3060	4	...
32 ,, ...	S. S. 31⅛	8	340	700	1040	1360	1620	1830	2020	2340	2640	2900	5	...
32 ,, ...	S. S. 31½	6	200	530	820	1100	1340	1540	1720	2060	...	...	5	...
32 ,, ...	S. S. 31½	4	260	580	870	1150	1400	1600	1770	1960	...	...	8	...
32* ,, ...	S. S. 31½	4	250	490	720	950	1170	1360	1560	1780	...	...	5	...
24 ,, ...	S. S. 23½	8	360	755	1125	1417	1670	1850	.....	.....	.....	.....	.....	.....
18 ,, ...	S. S. 17½	6	360	730	1080	1377	1600	1780	.....	.....	.....	.....	.....	.....
12 ,, ...	S. S. 11 1/16	4	360	720	1075	1337	1540	1700	.....	.....	.....	.....	.....	.....

Spherical Case with Iron Guns.

Distance.	24 Pdr. Elev. Deg.	24 Pdr. Fuze. Ins.	18 Pdr. Elev. Deg.	18 Pdr. Fuze. Ins.	12 Pdr. Elev. Deg.	12 Pdr. Fuze. Ins.
650	1¼	·2	1¼	·2	1½	·2
900	1¾	·3½	2	·4	2½	·4½
1000	2½	·5	3	·5¾	3½	·5¾

Ricochet with Iron Guns.

Distance.	24 Pdr. Charge. lbs.	24 Pdr. Charge. ozs.	24 Pdr. Elev. Deg	18 Pdr. Charge. lbs.	18 Pdr. Charge. ozs.	18 Pdr. Elev. Deg	12 Pdr. Charge. lbs.	12 Pdr. Charge. ozs.	12 Pdr. Elev. Deg
yds.									
400	...	12	6¼	...	9	6½	...	8	4½
,,	...	10	7⅜	...	...	...	...	6	6½
,,	...	8	11	...	...	...	...	...	...
600	1	8	4	1	2	5	...	12	4⅜
,,	1	4	5	1	...	5½	...	8	6
,,	1	...	6¼	...	12	6½	...	8	7½
800	2	...	3⅝	...	...	...	...	...	...
,,	1	8	5⅜	1	8	4½	1	...	4½
,,	1	...	8⅝	1	...	7	...	12	6½

The fixed charge for Iron Guns is ⅓ the weight of the shot.

For Hot Shot the charges should not be greater than one-fifth the weight of shot. When firing hot shot, cartridge bags should be well examined, so that no powder may escape through them on being rammed home, (which is done with a damp spunge head), a high gauge *dry* junk wad is next the cartridge and then a high gauge *soaked* wad. The gun being elevated one degree will allow the shot to roll home; over the shot a soaked junk wad if necessary.

To find the weight of an iron shot by its diameter.—As 64 is to 9 lbs. so is the cube of the diameter to its weight.

To find the diameter of an iron shot by its weight.—Multiply the cube root of the shot's weight by 1·923 for its diameter.

The initial Velocity of Shot being, under ordinary circumstances, 1600 feet per second, the velocity given by any other charge is found by dividing 1600 times the weight of the charge by the weight of the ball, and multiplying the square root of the quotient by 1600, and the product will be the velocity in feet, in the first second.

The time of flight of Shot or Shells is equal to one-fourth the square root of the product of the range in feet, multiplied by the natural tangent of the angle of elevation.

* Gun of 25 Cwt.

PRACTICE WITH BRASS GUNS.

Round Shot.

9 Pdr. Elev.	9 Pdr. Range	6 Pdr. Elev.	6 Pdr. Range
Deg.	yds.	Deg.	yds.
P. B.	300	P. B.	200
¼	400	¼	300
½	500	½	400
¾	600	¾	500
1	700	1	600
1¼	775	1¼	650
1½	850	1½	700
1¾	925	1¾	750
2	1000	2	800
2¼	1050	2¼	850
2½	1100	2½	900
2¾	1150	2¾	950
3	1200	3	1000
3¼	1250	3¼	1050
3½	1300	3½	1100
3¾	1350	3¾	1150
4	1400	4	1200

Canister Shot.

9 Pdr. Elev.	9 Pdr. Range	6 Pdr. Elev.	6 Pdr. Range
Deg.	yds.	Deg.	yds.
P. B.	150	P. B.	100
¼	200	¼	150
½	250	½	200
¾	300	¾	250
1	350	1	300

Spherical Case Shot.

9 Pdr. Fuze.	9 Pdr. Elev.	9 Pdr. Range	6 Pdr. Fuze.	6 Pdr. Elev.	6 Pdr. Range
Ins.	Deg	yds.	Ins.	Deg	yds.
2¼	1¼	600	2	1¼	600
3¼	1½	700	3	1½	700
4¼	2	800	4	2	800
5¼	2¼	900	5	2½	900
6	2½	1000	6	3	1000
7	2¾	1100	7	3½	1100
8	3¾	1200	8	4½	1200
9	4	1300	9	5	1300
10¼	5	1400	10¼	5½	1400
11¼	5¾	1500	11¼	6½	1500
12¼	6¾	1600	12¼	7½	1600
13¼	7¾	1700	14	8½	1700

Ricochet with Brass Guns.

Distance	9 Pdr. Charge. lbs.	9 Pdr. Charge. ozs.	9 Pdr. Elev.	6 Pdr. Charge. lbs.	6 Pdr. Charge. ozs.	6 Pdr. Elev.
yds			Deg.			Deg.
300	...	9	2	...	6	2
350	...	...	...	...	5	3¼
,,	...	2½	2½	...	7	2½
400	...	6	4½	...	6	3¾
,,	...	10	3	...	...	...
450	...	7	4½	...	6½	3½
,,	...	10	3½	...	...	...
500	...	6	6½	...	4	6
,,	...	...	...	...	7	3½
550	...	6	7½	...	4	7
,,	...	...	...	...	8	3½
600	...	11	4	...	8	4½

The area of a Circle, is found by squaring the diameter and multiplying that square by ·7854. **The solid content of a Cylinder,** is found by multiplying its length by the area.

Triangular Pile.—Multiply the base by the base plus 1, this product by the base plus 2, and divide by 6. —Let the base be 20. $\frac{20\times21\times22}{6}=1540$.

Oblong Pile.—From three times the length of the base, subtract the breadth less 1, multiply this by the breadth, and this product by the breadth plus 1, and divide by 6. Let the length be 50 and breadth 20. $\frac{(50\times3-19)\times20\times21}{6}=9170$.

Square Pile.—Multiply the corner row by the corner row plus 1, this product by twice the corner row plus 1, and divide by 6. Let the corner row be 36. $\frac{36\times37\times73}{6}=16,206$.

Madras Artillery { HOWITZERS. } Depot, Mount.

		IRON.		BRASS.		
		10 In.	8 In.	24Pdr.	12 Pdr.	4⅘ In.
Weight of	Howitzer ..... Cwt.	40-0-0	21-0-0	10-0-0	6-2-0	2-2-0
	Carriage	Iron.	Iron.	Wooden		Iron.
		26-1-18	24-1-20	12-0-0	10 2 12 (a)	†2-0-0
	Limber ..... „	13-2-0	13-2-0	10-0-0	10 0 0 (b)	..
	Total ..... „	79-3-18	58-3-20	32-0-0	27-0-12	4-2-0
Length of	Howitzer ..... Feet.	5	4	4	3-9¼	1-10-0
	Bore(c) ..... Ins.	58·75	46·8	46·5	44.	21·
	Chamber ..... „	11·25	9·5	8·47	6·8	4·5
Diameter.	Bore ..... „	10·	8·	5·66	4·52	4·52
	Chamber. Superior ..... „	10·	8·	5·66	4·52	2·7
	Chamber. Inferior ..... „	7·5	6·	4·25	3·4	2·24
Shot. Canister.	Balls weight ..... oz.	8	4	4	4	4
	No. in each	180	188	60	37	34
	Total weight ..... lbs.	102-12	54-3	16-14	10-8-8	10-4-0
Shot. Spherical Case.	Thickness ..... Ins.	..	·9	·6	·45	·45
	No. of Musket Balls in each	..	377	130	63	63
	Weight empty ..... lbs.	..	31-6-0	11-0-0	5-12-0	5-12-0
	„ filled ..... „	..	58-5-0	20-6-0	10-6-0	10-6
	Diameter of Shell .. Ins.	9·84	7·86	5·595	4·454	4·454
Shells Common.	Weight (average) empty ..... lbs.	87	44	16¼	8-3	7-8
	„ filled ..... „	90	46	17	8-8	8
	Thickness ..... Ins.	1·6	1·3	·85	·7	·7
Gauges.	High ..... „	9·88	7·90	5·62	4·476	4·476
	Low ..... „	9·80	7·82	5·57	4·432	4·432
Gunpowder. Proof of	Howitzer ..... lbs.	12	8	3	1-8	0-8
	Bouched Ordnance ... „	7	4	2	1-4	0-8
	Carriage ..... „	7	4	2	1-4	0-8
	Service charge ..... „	7	4	2	1-4	0-8
	Bursting Com. Shell „	2-10-0	1-14-0	0-10-0	0-5-0	0-5-0
	„ S. C. Shot .. oz.	..	15	6	4½	4½
	Exercise ..... lbs.	..	..	1-8-0	1-0-0	0-8-0
	Starting Fuzes ..... oz.	3	2½	1½	1	1
	Scaling ..... lbs.	1	0-12-0	0-8-0	0-4-0	0-2-0
Rounds carried with each Howitzer.	Canister	100	100	10	8	7
	Spherical Case	..	100	40	64	..
	Shells	1000	1000	30	60	80
	Carcasses	..	..	2	4	..
	Total	1100	1200	82	136	87
Diameter of Vent ..... Ins.		⅔	⅔	⅔	⅔	⅔
Windage ..... „		·16	·14	·065	·066	·056
Preponderance of Breech ..... Cwt.		5-0-7	3-0-0	0-3-15	0-1-18	0-0-22
Diameter of bore unserviceable ..... Ins.		10·05	8·05	5·70	4·56	4·56
„ „ Shell ..... „		9·75	7·80	5·54	4·40	4·40
Tangent of 1° ..... „		1·047	·8371	·837	·789	·383

* *10 Inch wooden* 43-0-3
" " " 27-1-14

† Mountain Train.
(a) Mountain Train iron Cwt. 2-3-14:
(b) " " " 2-1-0.
(c) Including Chamber.

PRACTICE WITH BRASS HOWITZERS.

Common Shells.

24 Pdr. 2 lbs.			12 Pdr. 1¼ lbs.		
Range	Elevn.	Fuze.	Range	Elevn.	Fuze.
yards.	Deg.	ths.	yards.	Deg.	ths.
250	P. B.	..	200	P. B.	..
300	¼	..	250	¼	..
350	½	..	300	½	..
400	¾	1	350	¾	..
450	1	1½	400	1	1¼
500	1¼	2	450	1⅛	1⅝
550	1½	2½	500	1⅜	2
600	1¾	3	550	1⅝	2⅜
650	2	3½	600	2	3
700	2¼	4	650	2¼	3⅜
750	2½	4½	700	2½	4
800	2¾	5	750	2⅝	4⅜
850	3	5½	800	3	5
900	3¼	6	850	3¼	5⅜
950	3½	6½	900	3½	6
1000	3¾	7	950	3⅝	6⅜
1025	4	7½	1000	4	7¼
1050	4¼	7½	1025	4¼	7½
1075	4½	7¾	1050	4½	7¾

Spherical Case Shot.

Range.	24 Pdr. 2 lbs.		12 Pdr. 1¼ lb.	
	Elevn.	Fuze.	Elevn.	Fuze.
yards.	Deg.	Ins.	Deg.	Ins.
600	1⅜	·3	2	·3
700	2⅛	·4	2½	·4
800	2⅝	·5	3	·5½
900	3⅛	·6	3½	·6½
1000	3⅝	·7	4	·7½
1100	4⅛	·8½	5	·8¾
1200	5	·9¼	6	1·
1300	6½	1·	7	1·1½
1400	7¾	1·1	8½	1·3
1500	8	1·2	9	1·4½
1600	8¾	1·3	9¾	1·6
1700	9½	1·4	10½	1·7½

Mountain Train.

12 Pdr. 3 Cwt. Charge 12 oz		4⅖ Inch Charge 8 oz	
Elev	Range	Elev	Range
Deg	yards.	Deg	yards.
P B.	200	P B.	84
1¼	343	1¼	137
2¼	709	2¼	256
3¼	793	3¼	336
4¼	837	4¼	450
6	1083	..	....

Canister.

Elevation.	24Pdr. 2 lbs.	12Pdr. 1¼ lb.
	Range	Range
Deg	yards.	yards.
P B.	150	100
½	200	150
¾	250	200
1	300	250
1¼	350	300
	400	350

Ricochet.

Range.	24 Pdr.		12 Pdr.		4⅖ Inch.	
	Charge.	Elev.	Charge.	Elev.	Charge.	Elev.
yds.	ozs.	Deg	ozs.	Deg	ozs.	Deg
300	16	2	5	5½	2¾	11
„	8	6½	..	..	..	..
400	9	7	5	6⅜	3½	12
„	11	6	7½	5½	..	..
„	16	3	10	3	..	..
450	..	..	6	6⅜	..	..
500	11⅜	7	7½	6½	4	13
„	9	8½	6⅜	7⅜	..	..
„	16	4⅜	..	..	..	..
550	11½	8	8	6	..	..
600	14	8	8	7	6	14
„	16	5⅜	10	5	..	..

Mad. Arty. {COM. SHELLS 10 INCH HOWITZER.} Depot, Mount.

Charge.		P. B.		1°		2°		3°		4°		5°		6°		7°	
		Flight.	Range.	Flight.	Range.	Flight.	Range.	Flight.	Range.	Flight.	Range.	Flight.	Range.	Flight.	Range.	Flight.	Range.
lbs	oz.	sec.	yds.	sec.	yds.	sec.	yds.	sec	yds.	sec	yds.	sec.	yds.	sec.	yds.	sec.	yds.
1	0	1·	44	1·3	61	1·4	78	1·7	96	1·9	114	1·9	131	2·1	151	2·4	170
1	8	1·1	57	1·4	89	1·5	120	1·8	152	2·1	184	2·2	215	2·4	248	2·6	280
2	0	1·15	69	1·5	115	1·7	161	2·	206	2·2	252	2·4	297	2·7	341	3·	386
2	8	1·2	82	1·6	142	1·8	201	2·2	260	2·4	318	2·7	376	3·	438	3·3	489
3	0	1·25	95	1·7	169	2·	242	2·4	314	2·7	385	3·1	454	3·4	523	3·7	594
3	8	1·3	108	1·8	195	2·1	281	2·5	366	2·8	449	3·2	530	3·6	612	4·	692
4	0	1·35	122	1·9	222	2·3	320	2·7	416	3·1	511	3·5	605	4·	697	4·4	788
4	8	1·4	135	2·	247	2·4	358	2·9	466	3·3	573	3·8	678	4·3	780	4·8	881
5	0	1·5	149	2·1	273	2·6	395	3·1	515	3·6	633	4·1	749	4·6	862	5·2	973
5	8	1·6	164	2·2	300	2·7	433	3·2	564	3·8	693	4·4	819	5·0	942	5·5	1063
6	0	1·7	179	2·3	326	2·9	470	3·4	612	4·	750	4·6	887	5·3	1019	5·6	1149
6	8	1·8	194	2·4	352	3·	507	3·6	659	4·2	807	4·8	953	5·5	1095	6·2	1235
7	0	1·9	209	2·5	377	3·2	542	3·8	704	4·4	862	5·1	1018	5·9	1168	6·5	1316

Charge.		8°		9°		10°		11°		12°		13°		14°		15°	
		Flight.	Range.	Flight.	Range.	Flight.	Range.	Flight.	Range.	Flight.	Range.	Flight.	Range.	Flight.	Range.	Flight.	Range.
lbs	oz.	sec.	yds.	sec.	yds.	sec.	yds.	sec	yds.	sec	yds.	sec.	yds.	sec.	yds.	sec.	yds.
1	0	2·5	190	2·9	210	3·	230	3·2	251	3·3	272	3·5	294	3·6	316	3·8	338
1	8	2·9	312	3·2	344	3·4	377	3·6	408	3·8	441	4·0	473	4·3	506	4·	538
2	0	3·2	430	3·5	474	3·7	518	4·0	562	4·3	605	4·6	648	4·9	691	5·2	733
2	8	3·7	546	4·	602	4·3	656	4·6	711	4·9	765	5·2	818	5·6	876	5·9	922
3	0	4·1	659	4·4	726	4·7	791	5·1	856	5·5	919	5·9	982	6·3	1043	6·6	1104
3	8	4·4	770	4·8	847	5·2	922	5·6	997	6·0	1070	6·4	1142	6·9	1212	7·3	1281
4	0	4·9	877	5·2	964	5·7	1049	6·2	1134	6·7	1217	7·2	1299	7·6	1379	8·	1456
4	8	5·3	981	5·8	1078	6·2	1173	6·8	1266	7·3	1358	7·8	1448	8·3	1535	8·7	1621
5	0	5·6	1082	6·	1188	6·6	1293	7·2	1395	7·8	1496	8·4	1594	8·9	1689	9·4	1783
5	8	6·1	1181	6·6	1297	7·2	1401	7·8	1521	8·4	1629	9·0	1735	9·6	1838	10·1	1939
6	0	6·2	1279	6·8	1401	7·4	1523	8·1	1642	8·8	1759	9·5	1872	10·3	1982	10·8	2090
6	8	6·9	1371	7·2	1504	8·	1633	8·8	1760	9·6	1834	10·4	2004	11·	2122	11·7	2236
7	0	7·	1460	7·6	1601	8·3	1739	9·1	1873	9·9	2004	10·8	2131	11·7	2255	12·3	2376

Fuses burn 1 inch in 5 seconds.—**Portfires** 1 inch in 1 minute.—**Slow match** 1 inch in 10 minutes.—**Quick match** 1 foot in 3 seconds.—**Carcasses** from 8 to 12 minutes.—**Fire Balls** from 10 to 15 minutes.

Mad. Art. {COM. SHELLS 8 INCH HOWITZERS.} Depot Mount.

Charge.		P. B.		1°		2°		3°		4°		5°		6°		7°	
		Flight	Range	Flight	Range	Flight	Range	Flight	Range	Flight	Range	Flight	Range	Flight	Range	Flight	Range
lbs	oz.	sec.	yds.	sec.	yds.	sec.	yds.	sec	yds.	sec	yds.	sec.	yds.	sec.	yds.	sec.	yds.
0	8	1·	41	1·2	54	1·3	68	1·5	82	1·6	95	1·8	109	2·	123	2·1	134
1	0	1·1	65	1·3	99	1·6	133	1·8	166	2·	198	2·3	231	2·5	263	2·7	294
1	8	1·2	89	1·5	104	1·8	198	2·1	251	2·4	303	2·7	355	3·	405	3·3	454
2	0	1·3	112	1·7	189	2·1	264	2·4	337	2·8	409	3·2	480	3·6	548	3·9	615
2	8	1·4	134	1·9	234	2·3	331	2·8	425	3·2	517	3·6	607	4·1	693	4·5	777
3	0	1·6	156	2·1	278	2·6	399	3·1	514	3·6	627	4·1	736	4·7	840	5·1	941
3	8	1·7	176	2·2	323	2·8	467	3·4	605	4·	738	4·6	866	5·2	988	5·7	1106
4	0	1·8	196	2·4	367	3·1	535	3·7	699	4·4	851	5·	998	5·8	1138	6·3	1272

Charge.		8°		9°		10°		11°		12°		13°		14°		15°	
		Flight	Range	Flight	Range	Flight	Range	Flight	Range	Flight	Range	Flight	Range	Flight	Range	Flight	Range
lbs	oz.	sec.	yds.	sec.	yds.	sec.	yds.	sec	yds.	sec	yds.	sec.	yds.	sec.	yds.	sec.	yds.
0	8	2·3	150	2·4	164	2·6	177	2·8	291	2·9	205	3·	218	3·2	232	3·4	246
1	0	3·	326	3·2	355	3·4	386	3·6	417	3·8	446	4·	475	4·3	504	4·5	533
1	8	3·6	502	3·9	548	4·2	595	4·5	641	4·8	685	5·	729	5·4	772	5·6	814
2	0	4·3	680	4·7	743	5·1	804	5·4	864	5·7	922	6·	979	6·4	1034	6·7	1088
2	8	5·	859	5·4	939	5·9	1013	6·3	1086	6·7	1157	7·	1226	7·5	1292	7·8	1355
3	0	5·7	1038	6·2	1137	6·7	1221	7·2	1306	7·6	1390	8·	1469	8·5	1544	9·	1615
3	8	6·4	1219	6·9	1327	7·5	1430	8·	1528	8·5	1621	9·	1709	9·6	1792	10·1	1820
4	0	7·	1409	7·7	1538	8·3	1638	8·9	1743	9·5	1848	10·	1945	10·7	2035	10·2	2116

Ricochet.

Range.	10 Inch. Charge.		Elv.	8 Inch. Charge.		Elv.
Yards.	lbs.	oz.	deg.	lbs.	oz.	deg.
300	...	...	...	...	...	...
,,	...	...	...	...	...	...
400	2	8	6½	1	8	6
,,	2	...	8½	1	...	9
500	...	...	...	...	...	...
,,	...	...	...	...	...	...
600	3	...	6½	1	8	9
,,	2	8	8½	2	...	6½
800	4	...	6½	2	8	6½
,,	3	8	7½	2	...	8½

Sphl. Case. 8 inch 4 lbs.

Range	Fuze.	Elevn.
yds.	ins.	deg.
600	·3½	2
700	·5	4
900	.7	5
1100	1·0	6
1200	1·1	7
1350	1·4	8¼
1500	1·7	10

Remarks on Ricochet Firing.

1. In the Field the Gun should seldom be elevated above 3 degrees, the objects fired at being generally Cavalry and Infantry.
2. In the Ricochet of a fortification the best elevation is from 6 to 9 degrees, seldom above 10 degrees.
3. Charges should be from one quarter to nearly half of those for Service.
4. The elevation to be given by the tangent scale, and the gun laid at the top of the work.
5. The shot to be projected upwards with so slow a motion, that it will begin to descend before it arrives over the work, and strike the ferre-plein within a few feet of the interior slope of the parapet, and make several grazes; while at the same time it should retain sufficient force to dismount the guns and disable the gunners and carriages.
6. Begin with such a charge and elevation as will cause the shot to strike or make its first graze on the parapet, and continue this until the precise degree of elevation is ascertained.

Mad. Arty. {COM. SHELLS 10 INCH HOWITZER.} Depot, Mount.

Charge.		P. B.		1°		2°		3°		4°		5°		6°		7°	
		Flight.	Range.	Flight.	Range.	Flight.	Range.	Flight.	Range.	Flight.	Range.	Flight.	Range.	Flight.	Range.	Flight.	Range.
lbs	oz.	sec.	yds.	sec.	yds.	sec.	yds.	sec	yds.	sec	yds.	sec.	yds.	sec.	yds.	sec.	yds.
1	0	1·	44	1·3	61	1·4	78	1·7	96	1·9	114	1·9	131	2·1	151	2·4	170
1	8	1·1	57	1·4	89	1·5	120	1·8	152	2·1	184	2·2	215	2·4	248	2·6	280
2	0	1·15	69	1·5	115	1·7	161	2·	206	2·2	252	2·4	297	2·7	341	3·	386
2	8	1·2	82	1·6	142	1·8	201	2·2	260	2·4	318	2·7	376	3·	438	3·3	489
3	0	1·25	95	1·7	169	2·	242	2·4	314	2·7	385	3·1	454	3·4	523	3·7	594
3	8	1·3	108	1·8	195	2·1	281	2·5	366	2·8	449	3·2	530	3·6	612	4·	692
4	0	1·35	122	1·9	222	2·3	320	2·7	416	3·1	511	3·5	605	4·	697	4·4	788
4	8	1·4	135	2·	247	2·4	358	2·9	466	3·3	573	3·8	678	4·3	780	4·8	881
5	0	1·5	149	2·1	273	2·6	395	3·1	515	3·6	633	4·1	749	4·6	862	5·2	973
5	8	1·6	164	2·2	300	2·7	433	3·2	564	3·8	693	4·4	819	5·0	942	5·5	1063
6	0	1·7	179	2·3	326	2·9	470	3·4	612	4·	750	4·6	887	5·3	1019	5·6	1149
6	8	1·8	194	2·4	352	3·	507	3·6	659	4·2	807	4·8	953	5·5	1095	6·2	1235
7	0	1·9	209	2·5	377	3·2	542	3·8	704	4·4	862	5·1	1018	5·9	1168	6·5	1316

Charge.		8°		9°		10°		11°		12°		13°		14°		15°	
		Flight.	Range.	Flight.	Range.	Flight.	Range.	Flight.	Range.	Flight.	Range.	Flight.	Range.	Flight.	Range.	Flight.	Range.
lbs	oz.	sec.	yds.	sec.	yds.	sec.	yds.	sec	yds.	sec	yds.	sec.	yds.	sec.	yds.	sec.	yds.
1	0	2·5	190	2·9	210	3·	230	3·2	251	3·3	272	3·5	294	3·6	316	3·8	338
1	8	2·9	312	3·2	344	3·4	377	3·6	408	3·8	441	4·0	473	4·3	506	4·	538
2	0	3·2	430	3·5	474	3·7	518	4·0	562	4·3	605	4·6	648	4·9	691	5·2	733
2	8	3·7	546	4·	602	4·3	656	4·6	711	4·9	765	5·2	818	5·6	876	5·9	922
3	0	4·1	659	4·4	726	4·7	791	5·1	856	5·5	919	5·9	982	6·3	1043	6·6	1104
3	8	4·4	770	4·8	847	5·2	922	5·6	997	6·0	1070	6·4	1142	6·9	1212	7·3	1281
4	0	4·9	877	5·2	964	5·7	1049	6·2	1134	6·7	1217	7·2	1299	7·6	1379	8·	1456
4	8	5·3	981	5·8	1078	6·2	1173	6·8	1266	7·3	1358	7·8	1448	8·3	1535	8·7	1621
5	0	5·6	1082	6·	1188	6·6	1293	7·2	1395	7·8	1496	8·4	1594	8·9	1689	9·4	1783
5	8	6·1	1181	6·6	1297	7·2	1401	7·8	1521	8·4	1629	9·0	1735	9·6	1838	10·1	1939
6	0	6·2	1279	6·8	1401	7·4	1523	8·1	1642	8·8	1759	9·5	1872	10·3	1982	10·8	2090
6	8	6·9	1371	7·2	1504	8·	1633	8·8	1760	9·6	1834	10·4	2004	11·	2122	11·5	2236
7	0	7·	1460	7·6	1601	8·3	1739	9·1	1873	9·9	2004	10·8	2131	11·7	2255	12·3	2376

Fuzes burn 1 inch in 5 seconds.—**Portfires** 1 inch in 1 minute.—**Slow match** 1 inch in 10 minutes.—**Quick match** 1 foot in 3 seconds.—**Carcasses** from 8 to 12 minutes.—**Fire Balls** from 10 to 15 minutes.

Mad. Art. {COM. SHELLS 8 INCH HOWITZERS.} Depot Mount.

Charge.		P. B.		1°		2°		3°		4°		5°		6°		7°	
		Flight	Range	Flight	Range	Flight	Range	Flight	Range	Flight	Range	Flight	Range	Flight	Range	Flight	Range
lbs	oz.	sec.	yds.	sec.	yds.	sec.	yds.	sec	yds.	sec	yds.	sec.	yds.	sec.	yds.	sec.	yds.
0	8	1·	41	1·2	54	1·3	68	1·5	82	1·6	95	1·8	109	2·	123	2·1	134
1	0	1·1	65	1·3	99	1·6	133	1·8	166	2·	198	2·3	231	2·5	263	2·7	294
1	8	1·2	89	1·5	104	1·8	198	2·1	251	2·4	303	2·7	355	3·	405	3·3	454
2	0	1·3	112	1·7	189	2·1	264	2·4	337	2·8	409	3·2	480	3·6	548	3·9	615
2	8	1·4	134	1·9	234	2·3	331	2·8	425	3·2	517	3·6	607	4·1	693	4·5	777
3	0	1·6	156	2·1	278	2·6	399	3·1	514	3·6	627	4·1	736	4·7	840	5·1	941
3	8	1·7	176	2·2	323	2·8	467	3·4	605	4·	738	4·6	866	5·2	988	5·7	1106
4	0	1·8	196	2·4	367	3·1	535	3·7	699	4·4	851	5·	998	5·8	1138	6·3	1272

Charge.		8°		9°		10°		11°		12°		13°		14°		15°	
		Flight	Range	Flight	Range	Flight	Range	Flight	Range	Flight	Range	Flight	Range	Flight	Range	Flight	Range
lbs	oz.	sec.	yds.	sec.	yds.	sec.	yds.	sec	yds.	sec	yds.	sec.	yds.	sec.	yds.	sec.	yds.
0	8	2·3	150	2·4	164	2·6	177	2·8	291	2·9	205	3·	218	3·2	232	3·4	246
1	0	3·	326	3·2	355	3·4	386	3·6	417	3·8	446	4·	475	4·3	504	4·5	533
1	8	3·6	502	3·9	548	4·2	595	4·5	641	4·8	685	5·	729	5·4	772	5·6	814
2	0	4·3	680	4·7	743	5·1	804	5·4	864	5·7	922	6·	979	6·4	1034	6·7	1088
2	8	5·	859	5·4	939	5·9	1013	6·3	1086	6·7	1157	7·	1226	7·5	1292	7·8	1355
3	0	5·7	1038	6·2	1137	6·7	1221	7·2	1306	7·6	1390	8·	1469	8·5	1544	9·	1615
3	8	6·4	1219	6·9	1327	7·5	1430	8·	1528	8·5	1621	9·	1709	9·6	1792	10·1	1820
4	0	7·	1409	7·7	1538	8·3	1638	8·9	1743	9·5	1848	10·	1945	10·7	2035	10·2	2116

Ricochet.

Range.	10 Inch. Charge.		Elv.	8 Inch. Charge.		Elv.
Yards.	lbs.	oz.	deg.	lbs.	oz.	deg.
300	...	...	...	...	...	...
..	...	...	...	...	...	...
400	2	8	6½	1	8	6
..	2	...	8½	1	...	9
500	...	...	...	...	...	...
..	...	...	...	...	...	...
600	3	...	6½	1	8	9
..	2	8	8½	2	...	6½
800	4	...	6½	2	8	6½
..	3	8	7½	2	...	8½

Sphl. Case. 8 Inch 4 lbs.

Range.	Fuze.	Elevn.
yds.	ins.	deg.
600	·3½	2
700	·5	4
900	·7	5
1100	1·0	6
1200	1·1	7
1350	1·4	8½
1500	1·7	10

Remarks on Ricochet Firing.

1. In the Field the Gun should seldom be elevated above 3 degrees, the objects fired at being generally Cavalry and Infantry.
2. In the Ricochet of a fortification the best elevation is from 6 to 9 degrees, seldom above 10 degrees.
3. Charges should be from one quarter to nearly half of those for Service.
4. The elevation to be given by the tangent scale, and the gun laid at the top of the work.
5. The shot to be projected upwards with so slow a motion, that it will begin to descend before it arrives over the work, and strike the terre-plein within a few feet of the interior slope of the parapet, and make several grazes; while at the same time it should retain sufficient force to dismount the guns and disable the gunners and carriages.
6. Begin with such a charge and elevation as will cause the shot to strike or make its first graze on the parapet, and continue this until the precise degree of elevation is ascertained.

Madras Artillery	CARRONADES.					Depot, Mount.
		68 Pdr.	42 Pdr.	32 Pdr.	24 Pdr.	18 Pdr.	12 Pdr.
Weight of	Carronade.....Cwt.	36	22	17	13	10	6
	Carriage..... „	17-3-0	10-2	9	8	6-3-0	6-1-0
	Total..... „	53-3-0	32-2	26	21	16-3-0	12-1-0
Length of	Carronade.....Feet.	5-4-0	4-6	4	3-9	3-4	2-8
	Chamber.....Ins.	..	..	4·6	4·	3·43	3·4
Canister Shot.	Balls weight.....ozs.	8	8	8	8	6	4
	No. in each.....	90	66	40	32	31	32
	Total weight.....lbs.	47-5-8	33-11	20-13	16-12-8	12-14-0	8-3-8
Gauges.	High.....	7·95	6·795	6·207	5·639	5·124	4·476
	Low.....	7·90	6·729	6·147	5·584	5·074	4·432
Gunpowder. Proof of	Carronade,.....lbs.	13	9	8	6	4	3
	Carriage ..... „	5-10	3-8	2-10	2	1-8	1
	Service Charge... „	Highest ⅛ of Shot, Lowest $\frac{1}{16}$ of Shot.					
	Scaling..... „	2	1-8	1-6	1	0-12	0-8-0
	Bursting Shell.... „	1-14	1-0	0-14	0-12	0-10	0-8-0
Proportion between Gun and Shot.. „		59	58	59	60	62	56

The advantages a Carronade possesses are the great diminution of weight compared with a gun of similar calibre; the small charge of powder, which is only $\frac{1}{12}$ weight of shot, and the greater facility with which it is loaded: some of the smaller natures are found to answer well in case-mates and in retired flanks of Fortresses. The 68 Pdr. is likewise of great advantage in siege operations with Shells, and is still used with battering trains with good effect.

Calibre.	Charge.		Range in Yards.					
	lbs.	ozs.	P.B.	1°	2°	3°	4°	5°
68 Pdr.....	5	10½	270	540	812	1042	1240	1420
42 „	3	8	240	515	810	983	1180	1350
32 „	2	10½	235	486	705	904	1100	1260
24 „	2	0	225	435	650	826	1000	1150
18 „	1	8	220	430	620	787	950	1100
12 „	1	0	205	375	580	738	880	1000

When firing Spherical Case Shot with the 68 Pdr. the following elevations and length of fuze are required, viz.

3° and 3ths. of fuze for 650 yds.
4° „ 5 „ „ 900 „
5° „ 7 „ „ 1100 „
with a charge of 5 lbs. 11 ozs.

For Ricochet at 600 yards Charge 1½ lb. 8½ deg. with shells.
„ „ 9 „ with shot.

CORDAGE.

Ropes, Cables, and all other descriptions of cordage are distinguished by their circumference, thus, a two inch rope means a rope two inches in circumference.

To find the weight of a Rope.—Multiply the length in fathoms by the square of the circumference, and divide the product by 480 for the weight in cwts.

To find the strength of a Rope, or the weight it will support.—Square the circumference, and divide by 6 for the description of rope generally employed, if new and of the best quality divide by 5 instead of 6.

Madras Artillery {CONGREVE ROCKETS.} Depot, Mount.

PRACTICE TABLE OF NEW PATTERN CONGREVE ROCKETS.

	24 Pdr.		12 Pdr.		6 Pdr.		3 Pdr.	
	Elevn.	Range yards.	Elevn.	Range yards.	Elevn.	Range yards.	Elevn.	Range yards.
	°		°		°		°	
A	47	3300	40	3000	37	2300	25	1800
B	27	2000	20	1500	15	1100	12	850
C	17	700	10	420	10	420	8	420

A.—If the whole length of the Fuze be left in the Shell.

B.—If the whole of the Fuze composition is bored out and the Rocket composition left entire.

C.—If the Rocket composition be bored into within one inch of the top of the cone or in the 24 Pounder, 1½ inch.

If the Rocket is to be used as a shot Rocket, the only thing to be attended to is to take care that there is no powder in the shell and that the plug is secured in the plug-hole. If the Rocket is to be used as a shell Rocket, at the longest range, the plug is to be taken out and the shell filled, the fuze left at its full length, and the plug replaced.—If at the shortest range, the fuze is to be entirely bored through, and the Rocket composition bored into, to within one inch and a half of the top of the cone, in the 24-pounder Rocket, and to within one inch in the 12, 6, and 3 pounder Rockets.

When the wind is in front, add half a degree to these elevations, or deduct the same if the wind is in rear. At all times lay the rocket to *leeward*, and this deflection must be in proportion to the strength of the breeze and distance to the object, great attention ought to be paid to this, and to the manner in which the stick is screwed on, in order to ensure a true poise; adjust the tube deliberately after each round, and alter the elevation and direction if required. Rockets are most advantageous with 24 and 12 Pounders against troops, from 800 to 1000 yards; against buildings, posts, &c. 500 to 600; and not nearer than 400 yards. With 6 pounders about 300 yards, and never at greater ranges than 6 or 700 yards.

Ground vollies carry disorder into an enemy's ranks, especially Cavalry, for which purpose 12 pounders should be used in vollies of 6 or 8 when the enemy is 600 yards distant, and vollies of 8 to 12-6 pounders may be used when he arrives within 400 yards; these are also useful in skirmishing.

The Rocket is placed with its shoulder flush with the rear of the tube.

To find the distance of an object by the report of Fire Arms.—Multiply the number of seconds between the flash and the report by 1100 for the distance in feet.

Sound will be louder in proportion to the condensation of the air.—Water is one of the greatest conductors of sound; it can be heard on water nearly twice as far as upon land.

To find the distance by means of the tangent scale of a gun the height of the object being known.—Lay the gun by the line of metal for the top of the object, then raise the tangent scale till the top of it, and the notch on the muzzle are in line with the foot of the object, and note what length of scale is required. Then by similar triangles. As the length of the raised part of the tangent scale, is to the length of the gun, so is the height of the distant object to the distance required.

DIAMETER OF BORES, SHOT AND SHELLS, AND GAUGES.

	Nature of Ordnance.	Diameter of Bore.	Diameter of Shot and Shells.	Windage.	Gauges. High.	Gauges. Low.	Unserviceable Shot and Shells.	Unserviceable Ordnance.
		Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.
Guns. Carronades.	68 Pounder	8·05	7·925	·125	7·95	7·90	7·80	8·1
	42 "	6·84	6·765	·075	6·795	6·729	6·68	6·89
	32 "	6·25	6·177	·073	6·207	6·147	6·10	6·30
	24 "	5·68	5·611	·069	5·639	5·584	5·54	5·73
	18 "	5·16	5·099	·061	5·124	5·074	5·04	5·21
	12 "	4·52	4·454	·066	4·476	4·432	4·40	4·57
	9 "	4·14	4·10	·04	4·10	4·06	4·00	4·19
	6 "	3·60	3·567	·033	3·568	3·532	3·49	3·65
Guns. Iron.	12 Inch	12·	11·84	·16	11·88	11·80	....	12·05
	10 "	10·	9·84	·16	9·88	9·80	....	10·05
	8 "	8·05	7·925	·125	7·95	7·90	....	8·1
	68 Pounder	8·12	7·925	·195	7·95	7·90	7·80	8·17
	56 "	7·65	7·48	·17	7·51	7·45	....	7·7
	42 "	6·935	6·765	·17	6·795	6·729	6·68	6·985
	32 "	6·41	6·177	·233	6·207	6·147	6·10	6·46
	24 "	5·823	5·611	·212	5·639	5·584	5·54	5·873
	18 "	5·292	5·099	·193	5·124	5·074	5·04	5·342
	12 "	4·623	4·454	·169	4·476	4·432	4·40	4·673
Guns. Brass.	9 "	4·2	4·1	·1	4·1	4·06	4·00	4·24
	6 "	3·668	3·567	·101	3·568	3·533	3·49	3·708
	3 "	2·91	2·823	·087	2·833	2·803	2·77	2·95
Mortars and Howitzers.	13 Inch	13·	12·84	·16	12·88	12·80	12·75	13·05
	10 "	10·	9·84	·16	9·88	9·80	9·75	10·05
	8 "	8·	7·85	·1	7·9	7·82	7·80	8·05
	5½ "	5·66	5·595	·065	5·62	5·57	5·54	5·70
	4⅗ "	4·52	4·454	·066	4·476	4·432	4·40	4·56
	24 Pounder	5·66	5·595	·065	5·62	5·57	5·54	5·70
	12 "	4·52	4·454	·066	4·476	4·432	4·40	4·56

For each calibre there are two gauges, the high and low, shot ought to pass through the large and not through the small. Shot and shells are admitted into the Service by the high, and, founders low, gauge, but after admission they are not to be condemned until they pass through the unserviceable or low gauge. ·05 for Iron, and ·04 for brass Ordnance added to the diameter of the bore in the first column, gives the diameter of the enlarged or unserviceable bore.

The vents of all Ordnance are ⅜ of an inch in diameter; if any exceed three-tenths, the vent bolt is to be condemned.

Bouching Ordnance consists in screwing in a bolt of pure copper, (through the centre of which a vent has been previously drilled) about 1 inch in diameter, near the bottom of the bore, the bouch entering at an angle of 101° with reference to the axis of the piece, and clear of the metal of the breech.

Madras Artillery {LABORATORY COMPOSITIONS.} Depot, Mount.

Compositions for	Antimony.	Arsenic.	Charcoal.	Isinglass.	Mealed Powder.	Linseed Oil.	Pitch.	Resin.	Saltpetre.	Sulphur.	Spirits of Wine.	Sea Coal.	Tallow.	Thread Cotton.	Turpentine.	Vinegar.	Wax, Bees.
	lbs.	lbs.	lbs.	ozs.	lbs.	ozs.	lbs.	lbs.	lbs.	lbs.	pts.	lbs.	lbs.	ozs.	ozs.	pts.	lbs.
Balls, Fire.....	$\frac{5}{8}$	0	0	0	0	8	0	$1\frac{7}{8}$	$6\frac{5}{16}$	$2\frac{1}{2}$	0	0	0	0	0	0	0
„ Smoke	0	0	0	0	5	0	2	0	1	0	0	$1\frac{1}{2}$	1	0	0	0	0
Carcasses	$\frac{5}{8}$	0	0	0	0	0	0	$1\frac{7}{8}$	$6\frac{1}{4}$	$2\frac{1}{2}$	0	0	$\frac{5}{8}$	0	10	0	0
Fuzes	0	0	3	0	0	0	0	0	35	12	0	0	0	0	0	0	0
Gunpowder	0	0	$13\frac{1}{2}$	0	0	0	0	0	75	$11\frac{1}{2}$	0	0	0	0	0	0	0
Kit	0	0	0	0	0	0	3	9	0	0	0	0	1	0	0	0	3
Lights, Blue.....	1	$\frac{1}{2}$	0	0	0	0	0	0	9	2	0	0	0	0	0	0	0
Match, Quick	0	0	0	1	4	0	0	0	0	0	8	0	0	4	0	0	0
Portfires	0	0	1	0	0	0	0	0	44	14	0	0	0	0	0	0	0
Rockets	0	0	$3\frac{1}{2}$	0	0	0	0	0	8	2	0	0	0	0	0	0	0
„ Stars	1	0	0	2	$\frac{1}{4}$	0	0	0	4	1	$\frac{1}{4}$	0	0	0	0	1	0
Valenciennes	$\frac{5}{16}$	0	0	0	0	7	0	$1\frac{1}{2}$	$6\frac{1}{4}$	$2\frac{1}{2}$	0	0	0	0	0	0	0

Necessary Precautions for preparing Common Shells, and Spherical Case Shot for Service.

1st.—That the shells are well cleaned, gauged and examined.

2d.—That the fuzes are made to fit the fuze hole in the whole thickness of the metal of shell, and that, in rasping the fuzes, no ridges, or hollows are left.

3d.—If the fuze prove too small after rasping, which *must be avoided*, a little wax cloth should be wrapped round it so as to be set securely.

4th.—As a general rule, no fuze should be cut of a shorter length than one inch, (for the 10 and 8 inch Howitzer not shorter than 1·6 ins.) and the composition surplus to what is required, bored out with an auger.

5th.—When setting fuzes, oakum should be placed in the hollow of the setter (to preserve the capping of the fuze,) the setter moved at each blow; the blows of the driver to be made fair on the head of the setter; and the cup of the fuze only left above the shell.

6th.—After fuzes are set, a little kit should be worked round the fuze, at its junction with the shell, which will prevent the possibility, of the flame of the charge passing between the fuze and metal.

7th.—If shells are prepared in anticipation of an action, the range they are intended for, and length of fuze, should be marked on them.

Common Shells—have only the regulated quantity of bursting powder put in them, when used against troops; but if required to fire buildings, &c. a quantity of combustible matter is added, such as pieces of port-fire 2 or 3 inches long, or Carcass and Valenciennes composition driven into stars for the purpose.

Spherical Case Shot—are filled with leaden balls, the bursting powder then put in, and well shaken among them; after rasping and fitting the fuze, two strands of quick match are put up the cavity left by the bored out composition. The fuze is then set in the shell.

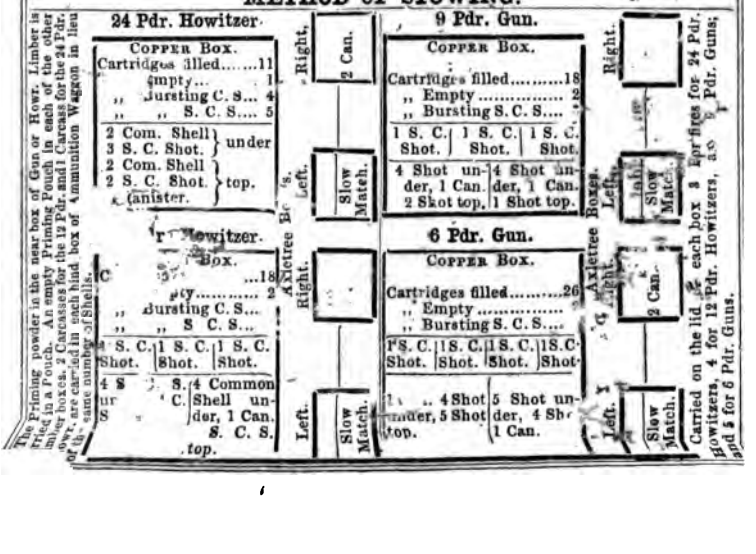
Madras Artillery — STOWING AMMUNITION — Depot, Mount.

Nature of Ammunition.	24 Pdr. Howr.			12 Pdr. Howr.			9 Pdr. Gun.			6 Pdr. Gun.		
	No. in each Ammunition Box.	No. in the Axletree Boxes	Total for one Subdivision.	No. in each Ammunition Box.	No. in the Axletree Boxes	Total for one Subdivision.	No. in each Ammunition Box.	No. in the Axletree Boxes	Total for one Subdivision.	No. in each Ammunition Box.	No. in the Axletree Boxes	Total for one Subdivision.
Shells Common...	*4	0	32	*3	0	64	0	0	0	0	0	0
Shot. Round.....	0	0	0	0	0	0	11	0	88	18	0	144
,, Sphl. Case...	5	0	40	8	0	64	3	0	24	4	0	32
,, Canister.....	1	2	10	1	0	8	2	0	16	2	2	18
Total...	10	2	82	17	0	136	16	0	128	24	2	194
Cartridges filled..	11	0	88	18	0	144	18	0	144	26	0	208
,, Empty	1	0	8	2	0	16	2	0	16	2	0	16
,, Priming	1	0	8	1	0	8	1	0	8	1	0	8
,, Bursting C.S.	4	0	32	8	0	64	0	0	0	0	0	0
,, ,, S. C. S.	5	0	40	8	0	64	3	0	24	4	0	32
Portfires	3	0	24	4	0	32	4	0	32	5	0	40

* In the rear boxes of the 12 Pdr. Waggon 4 carcasses are carried in lieu of the same number of shells, and in the rear boxes of the 24 Pdr. Waggon 2 carcasses in lieu of the same number of shells.

The priming powder in the near box of the Gun Limber is carried in the Priming Pouch instead of a Cartridge. An empty Priming Pouch is carried in each of the other Limber Boxes.

METHOD OF STOWING.



Carried Gun Limber Sma Store Box.	
Auger P. ze Brace	1
Bottle Copper with 6 ozs. of Spirits of Wine	1
Box with 50 Sphl. Case Fuzes*	1
,, with half skein of Quick Match	1
,, Copper dredging with 1 lb. of Mealed Powder	1
Cloth Waxed.....yards.	4
Compasses Common pair	1
,, Brass, pocket, Gunner's	1
Esses Iron	4
File Saw	1
Funnel Copper small	1
Hammer Wrench	1
Knife Laboratory	1
Mallet Setting	1
Match Cotton, Skein†	1
Pincers Fuze Brass	1
,, Gun	1
Rasp half round	1
Saw Fuze	1
Setters steel for Saw	1
Scale Gunter 2 feet Brass.	1
Scissors, pairs	1
Setter Fuze	1
Spike Gun Bagged	1
,, ,, Spring	1
Twine Europe fine....lbs.	1
Vice Hand Fuze wooden	1
Wrench Iron, for nuts: screw	1
Worms for Sponges	1

Carried on the Gun Carriage.		
Axe hand with Helve	1	On left cheek.
Bit Gun Steel small	1	On right cheek.
Bucket Water	1	Hooked in front.
Chain Locking	1	Hooked to loop under the trail, and to hook on right cheek.
Drift Vent Gun	1	On right cheek.
Hammer with Turnscrew	1	On right cheek.
Iron Priming	1	On right cheek.
Stock Portfire	1	On left cheek.
Spunges with Canvas Caps	2	One above, and one under the trail.

Carried on Limbers.		
Box Grease, to each Limber		Under each near Ammunition Box.
Prolon		Lashed between the Ammunition Boxes of Gun Limber.

Carried on Ammunition Waggo.		
Felling	1	Between the seats behind board.
Axe Pick	1	Head on front foot board. tweep boxes.
Axletree Iron, to a Battery	2	Slung under the Waggon wheel.
Bucket Water	1	Under rear foot board.
Chain Locking	1	Hooked to loop under the beam, and hook on near side.
Crowbar	1	Along side of and secured with the Felling Axe.
Handspike Common	1	Lashed underneath the beam.
Mamoties	2	Helves between coils of dragropes on front foot board.
Prop Wheel	1	Under the framing
Ropes Drag, Gun L. F. Sets	2	One set on rear, and one front foot board.
Wheels, spare, to a Battery	2	1 on saddle bl[illegible] of Waggon.

N. B.—One Keg containing 4 Gallons of grease slung to rear of Waggon, when no "Grease box" is attached to the Limber.

* Skeins of Line slinging allowed for lashing.

In all cases where Horse Artillery have their Waggons drawn by Bullocks, the following Stores are to be taken from Waggon-bodies, and placed upon the Gun Limber, as shown below.

Axe to be strapped on between Small Store Box and Foot Board.

Felling Axe on the perch, helve between the Ammunition Boxes, secured to the perch by a strap.

1 Set Drag Ropes, carried on the Foot Board, lashed to the Stay irons, and pole pin ring.

1 Mamotie, on the Foot Board, helve between the coils of the left Rope.

* The remainder of the Fuzes, belonging to the Subdivision, are packed in the small partitions in the small store box of Waggon Limber, in which, and the two boxes under Waggon, sufficient room will be found for the package of surplus small stores, &c.

† Skein in the Axletree box.

	24 Pdr. How.			12 Pdr. How.			9 Pdr. Gun.			6 Pdr. G		
	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.	cwt.	qrs.	l
Average weight of Gun.	10	..	..	6	2	..	10	..	..	6	..	
„ „ Carriage..	12	..	..	10	2	12	10	3	16	9	2	
„ „ Limber...	10	..	..	10	..	..	10	..	..	10	..	
„ „ Ammunition and Stores.....	5	1	15	4	2	4	4	2	8	4	2	
Total..	37	1	15	31	2	16	35	1	24	30	1	
Average weight of Ammunition Waggon ..	11	..	16	11	..	16	11	..	16	11	..	
„ „ Limber...	6	..	..	10	..	..	10	..	..	10	..	
„ „ Ammunition and Stores.....	13	1	22	11	2	22	11	2	25	11	2	
Total..	34	1	10	32	3	10	32	3	13	32	3	
Total weight of one Subdivision complete with Stores.....	71	3	25	64	1	26	68	1	9	63	..	

PRACTICAL RULES IN GUNNERY.

1. The first graze, with given elevation, and charge, being known, to det mine the charge for any other first graze, and elevation.

Multiply the known charge and elevation, into the proposed first graze, a the proposed elevation, into the known first graze, and divide the first prod by the last for the charge required, in ounces.

2. Given the range for one charge, to find the range for another charge, or charge for another range.

The ranges have the same proportion as the charges; that is, as one rang to its charge, so is any other range to its charge, the elevation of the piece be the same in both cases.

Table of Velocities, &c. of Shells.

Nature of Shells in inches.....	13	8	5½
Their weight (loaded) in pounds.....	203	90	17
Charge of powder (land service) do.....	8	3	2	1
The Velocities.....	436	500	629	693

3. **From Experiments on the Velocities of Shot,** the following results h been obtained.

1. **The time of a ball's flight is nearly as the range,** the Gun and elevat being the same

2. **The velocities decrease as the distances increase** in a proportion somewhat higher than the squares of the velocities throughout, *and subject only to a small variation.*

3. **Very little advantage is gained, in point of range, by increasing the service charge,** the velocities given by large charges being very soon reduced to those by moderate charges; those, for instance, given by half the shot's weight are reduced to an equality with those by one-third, after passing through a space of only 200 feet. (Vide 8.)

4. **Very little benefit is derived from increasing the length of Guns,** the velocity given by long guns of 22 calibres being reduced to an equality with that of short guns of 15½ calibres with similar charges, after passing through the following spaces, viz :—

With	¼	the shot's weight, about	285 feet.
„	½	do. do.	200
„	¾	do. do.	150
„	1	do. do.	115

5. **The resistance of the air,** against balls of different diameters with equal velocities is very nearly in the proportion of the squares of their diameters, or as their surfaces.

6. **A very great increase of velocity may be acquired by a decrease of windage,** from ½ to ¼ being lost by the windage of $\frac{1}{20}$ the diameter of the bore.

7. **By firing the charge in different parts,** (separately, or simultaneously;) by compressing the charge; by the use of wads; by varying the weight of the gun to lessen the recoil; or even by stopping the recoil entirely, no sensible change is produced in the velocity of the ball.

8. **The velocity increases with the charge,** to a certain point, peculiar to each gun; but by further increasing the charge, the velocity gradually diminishes; yet the recoil is always increased by an increase of charge. (Vide 3.)

9. **The velocities of balls fired with equal charges,** increase to a certain point, when the gun is longer, in a proportion which is nearly the middle ratio between the square, and cube roots of the length of the bore.

10. **When shot of the same diameter but of different densities are fired with the same charges of powder,** the velocities communicated to them are nearly in the inverse ratio of the square roots of their weights. Therefore, shot which are of different weights, and impelled by the firing of different charges of powder, acquire velocities which are directly as the square roots of the charges of powder, and inversely as the square roots of the weight of the shot. By making use of shot of a heavier metal than iron, (lead for instance) the momentum of the shot discharged with the same charge of powder would be increased in the ratio of the square root of the shot's weight, which would both augment the force of the blow with which it would strike, and also the extent of the range.

Compound Shot, or shells filled with lead, fired with charges increased ⅛ will increase the power of range considerably.

11. **The depths penetrated by balls of the same size into wood,** with different velocities or charges, are nearly as the square of the velocities. Balls of different sizes will penetrate to depths proportionate to their diameters: therefore a greater ball will not only make a larger hole, but will also penetrate farther than a small one with the same velocity.

To obtain with similar charges on a given ascent or descent, ranges corresponding with those obtained at 45° on a horizontal plane.

On a given ascent; add to 45° half the angle it makes with the horizon for the elevation required.

EXAMPLE.—Angle of ascent 20°.

$(20 \div 2) + 45 = 55°$, elevation required.

On a given descent; subtract from 45° half the angle it makes with the horizon for the elevation required.

EXAMPLE.—Angle of descent 20°

$45 - (20 \div 2) = 35°$, elevation required.

MOTION, FORCES, &c.

Gravity—A body falls nearly $16\frac{1}{12}$ feet in a second of time; and, consequently, at the end of that time, it has acquired a velocity of $32\frac{1}{6}$ feet:—the velocity is as the time, and the space as the square of either, and the spaces for each time as the odd numbers, which are the differences of the squares, denoting the whole spaces viz.

Times in seconds.....	1	2	3	4
Velocities in feet.....	$32\frac{1}{6}$	$64\frac{1}{3}$	$96\frac{1}{2}$	$128\frac{2}{3}$
Spaces in whole times.....	$16\frac{1}{12}$	$64\frac{1}{3}$	$144\frac{1}{4}$	$257\frac{1}{3}$
Spaces for each second.....	$16\frac{1}{12}$	$48\frac{1}{4}$	$80\frac{5}{12}$	$112\frac{7}{12}$

of which spaces the common difference is $32\frac{1}{6}$ feet, the natural and obvious measure of the force of gravity: thus a body falling from a state of rest acquires a velocity to pass through 9 spaces in the 5th second of time: 7 in the 4th; 5 in the 3d; 3 in the 2d; and 1 in the 1st; thus it is $9+7+5+3+1=25$; which shows that the whole spaces passed through in 5 seconds equal the square of 5.

The momentum, or energy of a body falling through the atmosphere is the mass or weight, multiplied by the square root of the height it has fallen through, multiplied by 8·021.

Thus, a one-ounce ball falling from a height of 400 feet, would strike the earth with a momentum of

$$\underset{\text{oz.}}{1} \times (20 \times 8{\cdot}021) = \underset{\text{feet}}{160{\cdot}42} = \underset{\text{oz.}}{10{\cdot}026}.$$

$$\underset{\text{lbs.}}{}$$

Amplitude signifies the range of a projectile, or the right line upon the ground subtending the curvilinear path in which it moves.

The time of flight of different shot and shells is equal to the time a heavy body takes to descend freely from 4 times the highest point described by the curve of the projectile.

To find the time of descent.—Divide the given height or altitude by $16\frac{1}{12}$ and the square root of the quotient will be the time required. Thus, if the altitude is 1200 feet, and the time of descent is required. $1200 \div 16\frac{1}{12} = 74{\cdot}61$ the square root of which is 8·637 the time required.

MENSURATION OF PLANES AND SOLIDS.

Triangles, Right Angle.—The Hypothenuse is equal to the square root of the sum of the squares of the two sides. The perpendicular or base is found by taking from the square of the Hypothenuse, the square of the given side, and extracting the square root of the remainder.

Circle—Vide page 9.

Circular Ring.—The area is found by subtracting the square of the lesser diameter from the square of the greater, and multiplying the difference by ·7854.

The diameter of a Ball is to its circumference as 1 to 3·1416.

To find the diameter of a leaden Ball, its weight being given.—To 4 times the weight add half the weight, and $\frac{3}{100}$ of half the weight; and the cube root of this sum will be the diameter in inches, nearly.

To find the weight of a leaden Ball, its diameter being given. Take $\frac{1}{2}$ of the cube of the diameter, and from it subtract $\frac{1}{3}$ of this third, and the remainder will be the weight nearly.

To find the weight of an iron shell, its interior and exterior diameters being given. Take $\frac{7}{8}$ of the difference of the cubes of the external, and internal diameters, for the weight of the shell in pounds.

To find the quantity of powder a shell will contain.—Divide the cube root of the interior diameter in inches by 57·3, and the quotient will be the weight in pounds.

To find the side of a Cubical box to contain a given quantity of powder. Multiply the weight in pounds by 30, and the cube root of the product will be the side of the box in inches.

To find the content of a Cone.—Find the area of the base, and multiply that area by the perpendicular height, and take $\frac{1}{3}$ of the product.

To find the solidity of the Frustrum of a cone,—Add into one sum the areas of the two ends, and the mean proportional between them: take $\frac{1}{3}$ of that sum for the mean area, which multiply by the perpendicular height, or length of the frustrum.

NOTE.—A mean proportional is found thus: as one of the sides of the base is to the corresponding side of the other end, so is the area of the base to the mean proportional.

To find the solidity of a Sphere.—Cube the diameter, and multiply by ·5236.

NOTE.—The solidity of an Hemisphere is half that of the sphere.

To find the solid content of a Spherical Segment.—1. From three times the diameter of the sphere take double the height of the segment; then multiply the remainder by the square of the height, and this product by ·5236.

2. Or, to three times the square of the radius of the segment's base add the square of its height; then multiply the sum by the height, and the product by ·5236.

To find the quantity of powder to fill the chamber of a Mortar or Howitzer.—Multiply the content of the chamber in inches by *55*, and divide the product by 1728, and the quotient will be the quantity of powder in pounds.

NOTE.—The Conical chamber of a Mortar, or Howitzer, is formed of a hollow frustrum of a right cone, and of a hollow hemisphere. A Gomer chamber is formed of a hollow frustrum of a right cone.

The content of a **Conical** chamber, is ascertained, by finding the content of the hollow frustrum of the cone, and that of the hemisphere *(vide preceding Rules)*. The content of the **Gomer** chamber, by finding the *solidity of the frustrum of the cone.*

To find the quantity of powder to fill a rectangular box.—Divide the content (viz. length × breadth × depth) of the box in inches by 30 for the pounds of powder.

NOTE.—One pound of powder occupies 30 cubic inches when shaken, and 31·4132 when not shaken.

To find the quantity of powder to fill a cylinder.—Multiply the square of the diameter by the length, then divide by 38·2 for the pounds of powder.

To find what length a known cylinder (or bore of a gun) will be filled by a given weight of powder.—Multiply the weight in pounds by 38·2 and divide the product by the square of the diameter in inches for the length.

Gunpowder when ignited expands with a velocity of about *5000* feet per second, and the pressure of the fluid is about 2000 times that of air.

To find the content and weight of a piece of Ordnance.—Divide the length of the gun into as many sections as may be found necessary. Find the content of each, and from their sum subtract the content of a cylinder, whose length is equal to that of the bore, and its diameter equal to that of the calibre of the piece; multiply the difference (if it be a brass gun) by *5·0833*, (if an iron gun) by *4·2968*, and the product will be the weight in ounces.

NOTE.—A cubic inch of gun metal weighs *5·0833* ounces.
Do. do. of cast iron do. *4·2968* „

To find the content of a Cask.—Multiply half the sum of the areas of the two interior circles, viz. at the head, and bung, by the interior length for the content.

NOTE.—The content of any vessel in cubic feet, multiplied by 6·232 (or if in inches by ·003607) will give the number of *imperial gallons it will contain.*

Strength of Materials.—In all questions, or operations, having reference to the capacity, and weight of bodies, it will be useful to remember, that the *cubic foot*, which contains exactly 1728 *cubic inches*, contains very nearly 2200 *cylindric inches*; 3300 *spherical inches*; and 6600 *conical inches*. Thus the capacity of a box 60 inches long, and 30 inches square, is $60\times30\times30=54000$ cubic inches, or $31\frac{1}{4}$ cubic feet. The capacity of a cylinder 60 inches long, and 30 inches in diameter, is $54000\div2200=24\frac{6}{11}$ cubic feet. The capacity of a cone, whose altitude is 60 inches, and diameter of base 30 inches, is $54000\div6600=8\frac{2}{11}$ cubic feet.

Dimensions for Siege Batteries.

	feet.	Ins.
Thickness of Parapet at top	18	0
Height of Parapet,*	7	6
Distance of Embrasure from centre to centre without traverses	18	0
Do. with Traverses	22	0
Interior opening of Embrasure, (a)	2	0
Exterior do. (=⅓ thickness of Parapet, (b)	9	0
Height of Genouillere, for Garrison Carriage	2	3
„ do. Travelling do.	3	0
Width of Berm	3	0
Depth of Ditch	6	0
Width of do. at top	24	0
Do. do. at bottom	12	0
Interior Slope of Parapet, from ¼ to ⅓ height	..	..
Superior Slope per foot	0	1
Do. Mortar Batteries when revetted, per foot	0	1
Exterior Mortar Batteries, if not revetted, per foot	1	0
Distance of Traverse from Parapet	2	0
Length of do. =that of platform.	..	..
Breadth of do. at base	7	0
Do. do. at top	4	0
Length of Epaulment, sufficient to protect the rear of the Battery	..	..
Slope of the cheeks of embrasures at the neck per foot (⅓ their height)	0	2
Do. at the mouth per foot (⅓ do.)	0	3
Distance from the centre of an embrasure to the foot of the slope of an adjoining traverse	7	6
Distance from the centre of an embrasure to the foot of the slope of an adjoining epaulment	5	0

Thickness of Parapets against

Heavy Guns,	18 feet thick.
12 or 9 Pdrs.	12 or 14 feet thick,
6 Pdrs. &c.	8 feet „
Musketry,	4 „ „

An Elevated battery has its whole parapet raised above the natural surface of the ground, and to procure the mass of earth required, a ditch is usually dug directly in front of the parapet.

A Half Sunken battery has its interior space or terreplein sunk two feet below, and the sill about half its total height above the natural surface of the ground.

A Sunken battery, has the soles of the embrasures on a level with the natural ground, the terreplein being sunk sufficient for the solid, which will depend on the nature of the carriage to be used, the merlons are formed of the exeavated earth.

Casemates, or vaulted batteries are made bomb proof, and the embrasures are cut through the revetment.

Barbet batteries have no embrasures, the guns fire over the parapet.

Ricochet batteries are placed perpendicularly to the prolongation of the faces of the work, or of its covered way, so as to graze along the interior crest of the parapet.

Direct batteries, are placed parallel to the face upon which they are to fire in order to fire into the embrasures and silence the enemy's fire.

Breaching batteries, are established upon the covered way, or crest of the Glacis, in order to destroy the Revetment wall of the opposite work, and should be as near as possible, so that the Guns may strike the foot of the revetment.

(a) Measured on the sill. (b) Measured on the sole.

* In half sunken Batteries, 5 feet 6 inches, or 6 feet. In Sunken Batteries 5 feet.

Counter Batteries, are constructed against Flanks to neutralize the defence they afford to faces.

Distant Batteries need not exceed 12 or 14 feet in thickness at the top, but those within point blank range of the enemy must be from 15 to 18 feet thick.

Elevated Sand Bag Batteries.—The base of the interior slope of a Battery revetted with sand bags is rather broader than that of one revetted with fascines, being about one-third the height of the parapet. *Bushel Sand-bags* are now the only kind in use, and *when filled are of the following dimensions.*

Length 20 inches, breadth 10 inches, depth 5 inches.

Number required per gun, for the interior revetment.....	262
Do. do. do. for the cheeks	360
Total..	622

Sand Bags are laid *Header* and *Stretcher*, as in Masonry; the ends which are tied being always hid. As the sand bags near the neck of the embrasure would be destroyed after a few hours firing, and constantly require repairing, gabions, or casks should be substituted for them.

Howitzer Batteries are similar to those for Guns, except that the interior openings of the embrasures are 2 feet 6 inches, and the soles are raised, towards the front, about 10°, in order to cover the Gunners as much as possible.

Mortar Batteries are constructed with the same dimensions as Gun Batteries (the parapet being generally 8 feet high, and from 18 to 22 feet thick,) but as they have no embrasures, the ditch of elevated batteries is made two feet deeper to obtain the requisite quantity of earth. A preference would in general be given to the Sunken, or half Sunken profile for a Mortar Battery, on account of its requiring less time for its construction, and it being of no consequence whether the platforms are sunken, or otherwise.

Fascines are bundles of wood of various lengths, according to the purposes to which they are applied.

Fascines for a revetment should be strong and well bound. When small brushwood is used, *they are made 6 feet long, and 7 inches in diameter,* and are firmly bound with four or five withies or gads.

The Gads are made of tough twigs, first twisted until the fibres separate, the smaller end is then turned round, so as to form a loop, or noose.

Gabions are cylindrical baskets open at both ends, and are very commonly used to revet parapets. For the interior of parapets they should be 3 *feet in height and diameter.* The common gabions are 2 feet in diameter, and 2 feet 9 inches high.

For Siege Operations, the following is considered as a good proportion of Artillery.

$\frac{3}{5}$ or $\frac{4}{5}$ of Guns of which	$\frac{2}{10}$	of 24 Pdrs. for Ricochet Batteries and afterwards for Breaching.
	$\frac{3}{10}$	of 18 Pdrs. for Ricochet or Enfilading Batteries.
	$\frac{5}{10}$	of 18 Pdrs. or 12 Pdrs. for Batteries of direct fire.
$\frac{1}{5}$ or $\frac{2}{10}$ of Howrs.	$\frac{1}{10}$	Should be of the largest calibre.
of which	$\frac{1}{10}$	Should be of medium calibre.
of Mor-	$\frac{1}{10}$	Should be of large calibre for ruining buildings.
f which	$\frac{1}{10}$	Should be of small calibre for annoying working parties.

The Ammunition per day may be estimated as follows:

For each gun in the Breaching Batteries	90	rounds.
For do. do. to dismount the Enemy's guns	50	,,
For do. do. of the Ricochet battery at the commencement of the siege.	120	,,
For do. do. afterwards	50	,,
For each Howitzer	40	,,
For each Mortar	20	,,

The best position for guns, in order to form a breach, is on the glacis, within 15 or 18 feet of its crest; but if the foot of the revetment cannot be seen from this situation, they must be placed in the covered way, within 15 feet of the counterscarp.

The fire should be directed so as to cut the revetment by a horizontal line, six feet from the bottom (if the ditch be a dry one), and level with the surface of the water, when it is wet, to the extent of the breach required; then by cutting vertical lines at each end, and at intervals between them(not exceeding 30 feet), beginning always at the bottom until they reach the cordon: after these lines are cut, fire salvoes to bring down the masonry in masses.

Howitzers employed in the operations of a Siege are, in the first instance, used in the enfilading batteries of the first parallel, and afterwards, in the breaching batteries, to bring down the mass of earth which generally remains after a breach has been effected by the guns, thereby rendering the ascent too steep for an assault.

Mortars during a Siege are generally first arranged in Battery adjoining the first gun batteries, or upon the prolongation of the capital of works.

A Gun should not be engaged singly, but supported by another which can take up its fire. The firing should be steady and regular, intermissions being avoided. Horse Artillery should fire rapidly and independently. Take the enemy obliquely, if possible in masses—points of formations—or columns just formed. Advance as near as possible without bringing your guns under musketry-fire, reserving Shell for special occasions, and Case for close quarters. In attacking, render the enemy's fire as divergent as possible, and yours as concentrating. Avoid impeding the movements of the Troops, and drawing the fire on them. Do not disclose the positions you have chosen for Batteries until ready to occupy them. Oppose a concentrated fire by a Battery which may take the enemy in flank, and thus produce a cross fire.

Circumstances admitting, select as a position, ground which slopes gently towards the enemy; the firmer the better for Ricochet firing and Case. A terrace from 6 to 10 feet high affords a valuable position, as the enemy's shot will either bury itself or rebound over it.

Ammunition should not be expended in replying to the general fire with which in commencing his attack, the enemy will endeavour to obscure his object. When he attacks, the Artillery should disregard the fire of his guns, but play upon his attacking columns only.

When firing Shells at troops, they should be prepared to burst just over their heads; when fired on buildings or field works, after penetration. When using Shells at distances within 600 yards, the quantity of bursting powder should be reduced ¼.

As small Mortars are principally intended for use against Troops, it saves much time to have the charges fixed, and in cartridges; and the elevation only altered with reference to distance, three different charges would be ample, and might be numbered 1—2—3.

The component parts of powder are 75 parts of nitre, 11½ of sulphur, and 13½ of harcoal.

Cylinder charcoal is charcoal that has been burnt in iron cylinders; and **Pit charcoal** is charcoal burnt in common pits. The latter is used at Madras.

Gunpowder is manufactured, first, by minutely pulverizing the three ingredients, Nitre, Charcoal, and Sulphur, which, after being mixed in due proportions are intimately incorporated by hand; **a charge,** or 60 lbs. of the mixture is then moistened, and placed under the mill cylinders, each Cylinder weighing 4½ tons; after 100 revolutions, the composition called **mill** cake is put under a powerful lever press, and formed into **Press** cake, about a quarter of an inch thick; this, when dry, or nearly so, is broken by wooden mallets into small pieces, and reduced into grains by being put through sieves.

Pressing and Glazing lessen the propellent force of Gun Powder, but these processes render the Powder less susceptible of absorbing moisture, and better able to withstand the shaking and friction of carriage.

Good powder should be devoid of smell, and of uniform colour, approaching to that of a slate. The particles should be perfectly granulated, and free from cohesion. It should admit of being readily poured from one vessel to another.

The quality of powder is ascertained by its general appearance, its firmness, glazing, uniformity of grain, and density.

To test the purity of powder.—Lay a dram of it on a piece of clean writing-paper, and fire the heap by means of a red-hot iron wire: if the flame ascend quickly with a good report, leaving the paper free from white specks, and without burning holes in it, the goodness of the ingredients and proper manufacture of the powder may be safely inferred.

Good powder blasted upon a clean plate of copper, should leave no trace or mark of foulness.

Powder exposed for 17 or 18 days to the influence of the atmosphere ought not to increase materially in weight. One hundred pounds of powder should not absorb more than twelve ounces: if it increase in weight more than one per cent., the powder contains a deliquescent salt.

Dimensions of Powder Barrels.

	90 lbs. Feet.	Inches.	45 lbs. Feet	Inches.
Depth	1	9⅞	1	5⅞
Exterior Diameter at the head	1	3	1	0¼
„ „ at bulge	1	5	1	2¼
„ „ at bottom	1	3	1	0¼
Thickness of Stave at the head	0	1	0	1
„ „ „ „ bulge	0	0⅝	0	0⅝

The 90 lb. barrels are made to contain 100 lbs. and the 45 lb. barrels, 50 lbs. of powder each; but 90 lbs. only are put into the former, and 45 lbs. into the latter. This arrangement leaves room for the shifting of the powder, and preserves it betaking.

Barrels containing different powders are distinguished by the color of the marks on them (Red paint denoting C. P. and Blue paint M. P.) The initials of the Superintendent's name, date of manufacture, nature of powder, and medium range, are all marked on Gunpowder barrels.

Budge Barrels are used in batteries, more securely to keep the powder from accidental explosion. They hold from 40 to 60 pounds of powder. At one end there is a leather top, or hose, through which the powder is taken out, this top is closed and fastened by strings.

Proof of Gunpowder.—Each kind, viz., C. P. and M. P. is proved, by firing from an 8-Inch Iron Mortar 3 rounds of each powder with a 1 lb. charge, and 3 rounds with a 2 oz. charge, with a ball of 68 lbs. weight. M. P. is also proved, with a percussion musket and steel ball of 14½ drachms weight, at mango boards (soaked in water for 12 hours) ½ inch thick, placed in a frame 1 inch apart; the distance from the muzzle to the front board being 30 feet, and the charge 4½ drachms. The minimum range of gunpowder for service is 550 yards with a 1 lb. charge, and 63 yards with a 2 ozs. charge. The average range of pressed and glazed powder with the 1 lb charge is between 600 and 700 yards, and with 2 ozs. charge from 70 to 80 yards.

Proof of Gun Carriages.—All Gun Carriages are proved by firing 15 rounds from each piece, with service charge, one shot or dead shell (and two high junk wads for Heavy Field, one wad being put between the Cartridge and Shot, and one over the shot), at the following elevations, viz. 5 rounds P. B., 5 rounds medium, and 5 rounds at the highest elevation attainable. Carriages constructed of a new description of wood, or of a new pattern, undergo in addition to the above, an extraordinary proof of 30 rounds at P. B. 30 rounds medium, and 30 rounds at the highest elevation.

Proof of Mortar Beds.—Mortar beds are proved by firing 5 rounds with the chamber of the Mortar ⅔ full of Gunpowder with a dead shell, at 60 degrees elevation.

Proof of Ordnance.—Iron Guns are fired twice with one shot and two high junk wads; one between the cartridge and shot, and one over the shot. Brass guns thrice, with two shot and three wads: Charges as per *preceding Tables*. Mortars and Howitzers are fired twice with their chambers full of powder. Iron Mortars and Howitzers with a solid shot, and Brass ones with a shell. Guns are laid on skids at P. B. Mortars on proof beds at 75°, they are carefully primed, and a piece of portfire 1½ inch long fixed over the vent with clay, to enable the men to get under cover.

Newly Bouched Ordnance.—Guns and Howitzers which have been newly bouched, are mounted on their carriages, and six rounds of shot or shell with service charge of gunpowder are fired at P. B. (with two high junk wads, for Heavy Field) as laid down for Proof of Gun Carriages.

Mortars are mounted on their beds, and three rounds with their chambers half full of gunpowder with a shell, are fired at 45° elevation.

An examination should be made of all Gun Carriages after every five rounds and of mortar beds when the proof is completed.

BRIDGES.

To find the number of planks required to form a float to support a given weight.

1st.—Find the content of one plank, and multiply it by the specific gravity of the wood; the product will be the *weight of the timber.*

2d.—Multiply the same solid content by the specific gravity of water; the product will be the *weight of an equal bulk of water.*

Then take the difference of these two products, or weight, and it will be the weight one piece of timber will support without sinking. *Hence by proportion,* the number required to support the given weight may be found.

EXAMPLE.—Required the number of pine planks (length 18 feet breadth 1 foot 6 inches, and thickness 4 inches,) to form a float to support 50 cwt.

ft. ft. ins. ins. ft.

18×1—6×4= 9 content of one plank.

Spec. Grav. of 1 foot of pine in ozs.. 660×9=5940 ozs. weight of one plank.

Spec. Grav. of 1 foot of water in ozs.. 1000×9=9000 „ „ of water of equal bulk.

Difference..3060 „ weight one piece will support without sinking.

ozs. ozs.

then by proportion 3060 : 89600 :: 1 : $29\frac{43}{153}$ or 30 planks, the number required.

To find the number of Casks required to form a Raft to support a given weight.

1st.—Find the solid content of one Cask in cubic inches, and multiply it by the specific gravity of water; the product will be the weight of a quantity of water of equal bulk with the cask.

2d.—From this product, or weight, subtract the weight of the cask, and the remainder will be the weight it will support without sinking. *Then by proportion,* the number required for the formation of the Raft may be found.

EXAMPLE.—Required the number of Gunpowder Barrels (90 lbs.), of the following dimensions, to form a raft to support 70 cwt. Greatest interior diameter 15·75 ins. Least interior diameter 13 ins. Interior length 19 inches and weight 34 lbs.

15·75 × 15·75 × ·7854=194·8282875

13 × 13 × ·7854=132·7326

$\left\{\frac{194.8283 + 132.7326}{2}\right\}$ × 19=3111·8284 ins. or 1·8008 cubic feet content of one Cask.

1·8008 × 1000 = 1800·8 ozs. weight of water of equal bulk with the Cask.

1800·8 — 544 = 1256·8 ozs. weight one Barrel will support without sinking.

Then by proportion 1256·8 : 125440 :: 1 : $99\frac{1231}{1571}$ or 100 Barrels, the number required.

To find the number of Boats, or Pontoons, required to support a given weight.

The burthen a Boat, or Pontoon, will support without sinking beyond a given depth (the form of the boat, or pontoon, being known) must first be found, thus

1st.—Find the solid content of the part to be sunk, in cubic feet, and multiply it by the specific gravity of water.

2d.—Subtract the product from the weight of the boat, or pontoon, and the remainder will be the burthen it will support without sinking beyond the required depth.

Then by proportion, the number required to support the given weight may be computed.

NOTE.—In the construction of Bridges, should a rope require to be extended across a rapid river, the coil should be placed in the Boat (instead of on shore) and be payed out as the boat advances.

Displacement of water, 97½ cubic feet, equals 6088 lb., or 54½ cwt.

TABLE SHOWING THE RATE OF INCLINATION OF INCLINED PLANES FOR THE FOLLOWING ANGLES OF ELEVATION.

Angle.	One in.	Angle.	One in.	Angle.	One in.
0° 15′	228	3° 30′	17	7° 0′	8
0 30	114	3 45	16	7 30	7½
0 45	76	4 0	15	8 0	7
1 0	56	4 15	14	9 0	6½
1 15	46	4 30	13	10 0	6
1 30	38	4 45	12	11 0	5½
1 45	32	5 0	11½	12 0	5⅛
2 0	28	5 15	11	13 9	5
2 15	26	5 30	10½	14 0	4½
2 30	23	5 45	10	15 0	4
2 45	21	6 0	9½	16 0	3½
3 0	19	6 30	9	17 0	3½
3 15	18	6 45	8½	18 0	3½

The following are the dimensions of bags used for bursting open gates.

Length.		Breadth.		Contents of Powder.
Ft.	Ins.	Ft.	Ins.	lbs.
2	1	1	0	50
2	4	1	9	70
2	7	2	0½	100

They are made of leather covered with canvas, and are hooked upon the gate (by a gimblet or nail) as near the centre as possible, and fired by means of a port-fire passed through a hole in the bottom and well secured with twine.

To ascertain distances by means of the Rhombus.—Suppose F Fig. 1, Plate 1, the object, and A F the required distance. With a line or measuring tape, of a length equal to the side of the intended rhombus, the longer the better, lay down one side A B in the direction A F, and also with a second tape, B C, another side, in any convenient direction, for whether B be a right angle or not, is of no consequence; and put up two rods or arrows at A and C.

Then fasten two ends of two such lines at A and C, and extend them until the two other ends just meet at D. Let them be thus stretched upon the ground, and they will form the other two sides A D, C D, of the rhombus.

Next fix a mark or arrow at E, directly between C and F, upon the line A D, and measure A E, and E D, upon the tape.

Then by the property of similar triangles, it will be As ED : CD :: AE : AF, the distance required.

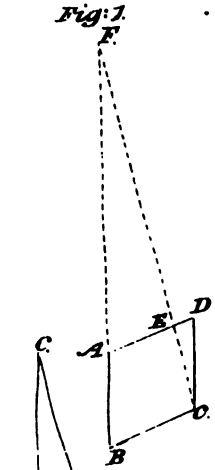
To ascertain distances by means of right angled triangles.—The distance from A to B, Fig. 2, being required. Place a Banner roll at A, and another at C at a right angle to the line A B, then ascertain the angle A C B, the natural tangent of which multiplied by the base A C in feet, will give the required distance from A to B, also in feet.

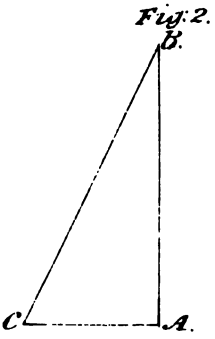
To ascertain the same by means of the Gunter's Scale.—The angle at B (the complement of the angle C) being known, extend with a pair of compasses from radius (45°) to the number of degrees on the line of Tangents corresponding to the angle B (say 26°), that extent will reach on the line of numbers, from the number corresponding with the base C A in feet (say 400 feet) to the distance from A to B also in feet, which in this case will be 820 feet.

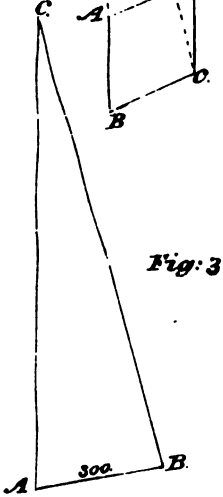
To ascertain distances by means of any triangle with the Gunter's Scale.—In the triangle Fig. 3, the angle A = 80°, B = 85° and consequently C = 15°; the line A B = 300 yards; required the distances from A to C, or from B to C. On the line of sines (Sin.) the space between 15° and 85° will extend on the line of Numbers from 300 to 1155 yards, = A C, and from 15° to 80° will reach from 300 to 1141 yards = B C.

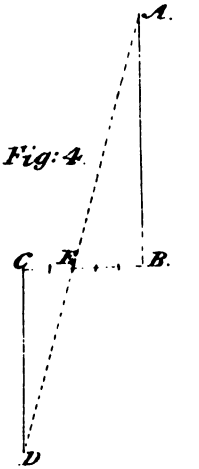
To ascertain the distances of an inaccessible object A Fig. 4.—Place a picket at B, and another at C, at any distance, say 100 yards, making A B C a right angled triangle, then divide B C into any number of equal parts, then from C move in a direction from the inaccessible object, making a right angle at C, and moving on in the line C D, until you bring yourself in a line with the object A, and cutting any one of the divisions, (say E) marked on B C; then C D, C E and B E being known; C E : C D :: B E : B A, the required distance.

For Distances by the report of **Fire Arms**, and by means of the **Tangent Scale** of a Gun, vide page 15.









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LIGHT FIELD CARRIAGE

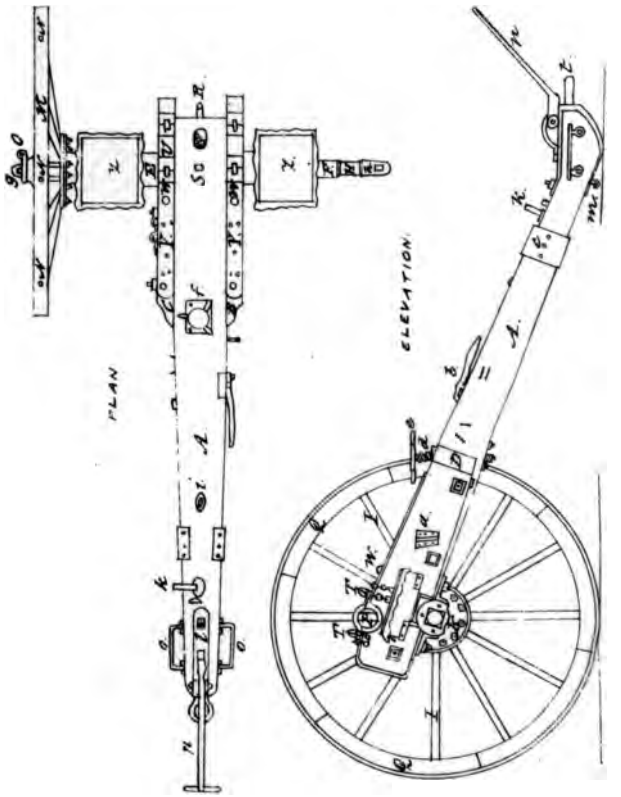

Plate 2

Light Field Carriage

References

A. Beam or Trail
B. Right Cheek.
C. Left ____ " ____
D. Ogee
E. Axletree Bed
F. ____ " ____ Arm
H. Groove to retain tar and grease
I. Spokes.
K. Naxe
M. Tire
N. ____ " ____ nails
O. Drag washer.
P. Trunnion Hole.
Q. Felloes
R. Bucket Hook.
S. Centre bolt
T. Eye bolts.
V. Cap squares
W. Garnish bolts.
Y. Garnish plates
a. Socket loop
b. Portfire cutter
c. Locking plate
d. Elevating Screw
e. ____ " ____ " Handles
f. ____ " ____ " box
g. Linch pin
h. ____ " ____ " hole
i. Friction point
k. Sponge Loop.
l. Trail Plate.
m. Loop for locking chain
n. Traversing Handspike
t. Pintle loop
X. Ammunition Boxes.

AMMUNITION WAGGON.

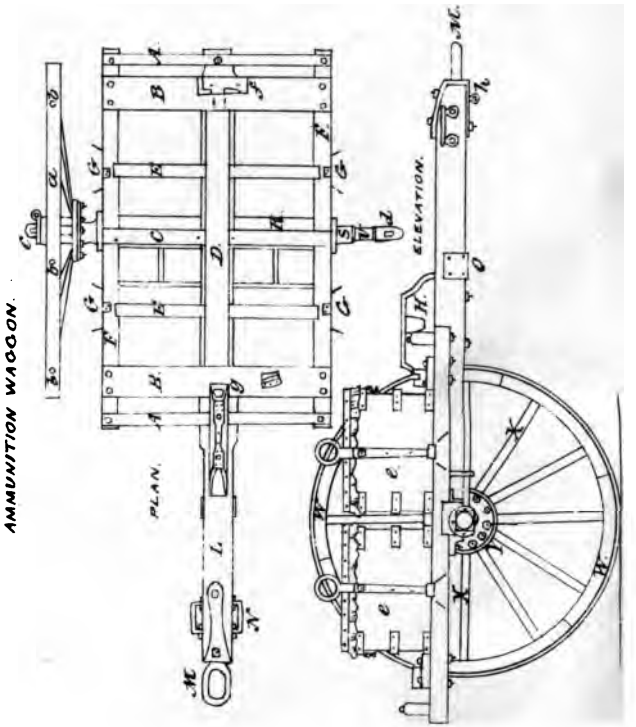

Plate. 3.

Immunition Waggon.

References.

A. Foot Bar.
B. Foot Board.
C. Bottom Cross. 1st size.
D. ___ " ___ " 2nd " ___.
E. ___ " ___ " 3rd " ___.
F. Side framing.
G. Keepers.
H. Saddle Block.
I. Beam.
M. Pintle Loop.
N. Limbering Handles.
O. Locking Plate.
R. Axletree Bed.
S. ___ " ___ Arm.
V. Groove to retain tar and grease.
W. Fellies.
X. Spokes.
Y. Nave.
a. Tire.
b. ___ " ___ nails.
c. Linch pin.
d. ___ " ___ " ___ hole.
e. Ammunition boxes.
f. Recess for Head of Felling Axe.
g. Recess for Helve of Pickaxe.
h. Loop for Locking chain.

LIGHT FIELD LIMBER

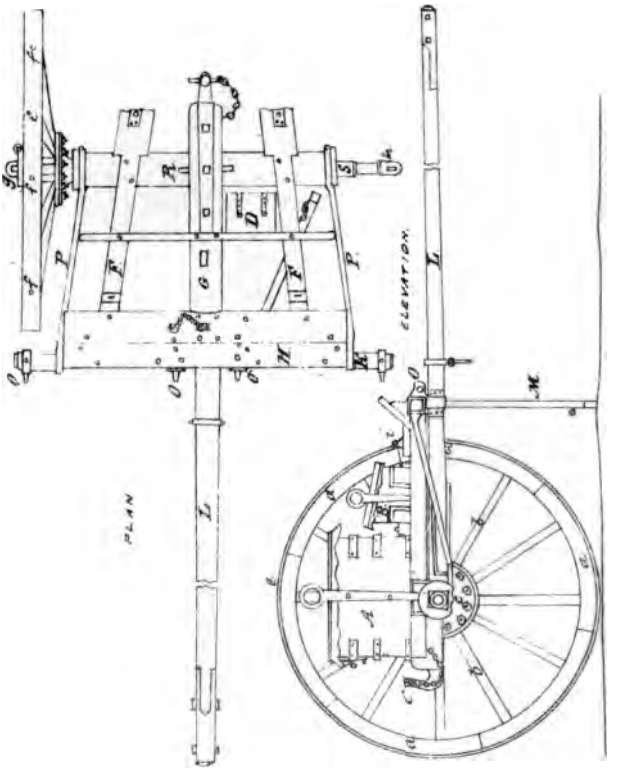

Plate 4

Light Field Limber

References

A. Ammunition boxes.
B. Small Store Box.
C. Pintle Hook
D. Grease box
F. Side framing
G. Centre___"
H. Foot Board.
K. Splinter bar.
L. Pole
M. "___prop
O. Draft loops.
P. Stay Irons
R. Axletree bed
S. ____arm
a. Felloes
b. Spokes
c Nave
d. Tire
f. ___nails.
g. Linch pin
h. ____hole
i. Pole pin.

PENDULUMS.

In a pendulum of a determined length, the time of vibration is the same whatever be the extent of the arc of that vibration.

The time of vibration is directly proportional to the square root of the length of the pendulum; and the time of vibration is inversely proportional to the square root of the force of gravity.

The force of gravity varies in different latitudes, the increment above the force at the equator being nearly as the square of the sine of the latitude; and since the length of the seconds pendulum is directly proportional to the force of gravity, the increment in its length above the length of the equator varies also as the square of the sine of the latitude.

Since the force of gravity without the earth's surface varies in the same latitude inversely as the square of the distance from the earth's centre, and the number of vibrations made by a pendulum in a day varies inversely as the time of vibration, and therefore directly as the square root of the force of gravity, it follows that the number of vibrations in a day varies inversely as the distance from the earth's centre.

A pendulum to vibrate half seconds must be ¼ the length of one that vibrates seconds; and a **pendulum to vibrate once in two seconds,** must be four times as long as one which vibrates seconds.

Thus a pendulum 39·035 inches is found to vibrate 60 times in a minute in the latitude of Madras; therefore to find how long pendulums should be to vibrate 30, 50 and 120 times in a minute in that latitude we say.

		ins	ins.	ins.
As 30^2	: 60^2 ::	39·035 :	156·14	or 39·035 × 4=156·14
50^2	: 60^2 ::	39·035 :	56·21	
120^2	: 60^2 ::	39·035 :	9·75875	or 39·035 ÷ 4=9·75875

Pendulums for seconds.

Deg. of Latitude	Length of Pendulum.	Deg. of Latitude	Length of Pendulum.
0	39·027	50	39·126
5	39·029	55	39·142
10	39·032	60	39·158
15	39·036	65	39·168
20	39·044	70	39·177
25	39·057	75	39·185
30	39·070	80	39·191
35	39·084	85	39·195
40	39·097	90	39·197
45	39.111		

Gravity is downward pressure, or weight, being the natural tendency of all bodies towards the centre of the earth.

Absolute gravity denotes the whole force with which a body tends downwards, as when the body is in empty space.

Specific Gravity denotes the relative or comparative gravity of any body, in respect to that of another body of equal bulk, or magnitude.

Centre of gravity is that point in a body or system of bodies, on which, if rested, or suspended, the whole would remain in a state of equilibrium about that point.

The Centre of gravity of a circle, regular polygon, prism, cylinder or sphere, is in its centre.

To render Ordnance Unserviceable by Spiking &c.

The most effectual method of rendering Ordnance unserviceable, is, to remove one, or even both, of the trunnions, which may be done by striking the end of the trunnion with repeated blows of a heavy sledge hammer; or by firing a shot against the trunnion, the muzzle being placed near the trunnion. Brass Ordnance may be rendered useless by firing whole or broken shot into the bore from another piece, or by firing a shot against the chase, which bulges the metal within the bore, and prevents the admission of the charge.

For spiking Ordnance, there are two kinds of spikes; the jagged spike which is nearly square having all its angles cut like a file, but coarser and deeper, the points or jags being upwards; the other the spring spike, the head being like that of a musket ramrod, the lower part having a spring on one side opening upwards. The point is driven into the vent which presses the spring close to the body of the spike; when the spring has passed through the metal into the bore, it opens out, and cannot be drawn out from the outside until the spring is broken off or closed. Spring spikes are only used when it is expected the guns will be immediately retaken, as the spike can be so easily withdrawn. A nail or even a wooden peg may answer if a proper spike is not at hand.

If a temporary abandonment of the guns becomes necessary, take away the cap-squares, elevating screws, quoins, linchpins, and side arms.

Unspiking Ordnance.

If the gun has been spiked with the jagged spike, load with a charge of powder equal to half the shot's weight; lay a leader of quick match along the bore, (and extending sufficiently out of the gun to admit of the man firing the match getting under cover), and double shot the gun, introducing the shot, however, very carefully. Should the spike not be removed, the operation may be repeated.

When a Gun cannot be unspiked, the only means of rendering it serviceable is to drill another vent, about half an inch from the original one.

With brass guns it would be advisable, a day or two previous to the experiment, to scratch close round the spike with a graver, and put a few drops of nitric acid in the circle, which in a few hours will find its way down between the spike and the metal, particularly if the former does not completely fill the vent.

The spring spike is removed in the following manner; on one side of the head of the spike there is a small notch cut; this coincides with that side of the spike on which the spring is attached. This notch is placed towards the muzzle, and the spike drawn up as far as it can be by hand; the rammer head is then put into the bore and the spring pressed close to the body of the spike, the latter can then be drawn out of the vent.

MINES.—General Principles.

The greatest extent of an opening in the earth caused by a mine is six times in breadth, or diameter, the distance of the powder to the place from whence it forces an exit.

To find the charge to produce any desired diameter of excavation.—Globes are to each other as the cubes of their radii. Their radii are the hypothenuses of right angled triangles, of which the line of least resistance, and the semi-diameter of the excavation, are the other two sides.

The following will be the rule, the radius being found as above.

As the cube of the radius of the globe of compression in the following table, (having the same line of least resistance as the required globe) is to the cube of the radius of the required globe: so is the charge corresponding in the following table; to the charge required.

Line of least resistance.	Charge for the Mine.	
Feet.	lb.	oz.
1	0	2
2	0	12
3	2	8
4	6	0
5	11	11
6	20	4
7	32	2
8	48	0
9	68	5
10	93	12
11	124	12
12	162	0
13	205	15
14	257	4
15	316	4
16	384	0
17	460	9
18	546	12

This table is calculated upon a supposition, that the excavation of the mine is a paraboloid, having a base double the line of least resistance: and that 10 lb. 10 oz. of powder is sufficient for raising one cubic fathom of earth. By the rule above given may be found the charge for any mine, that shall only shake the ground, without making any excavation, by making the line of least resistance of the required globe, only equal to the radius of the globe of compression.

The charges thus found by means of this table, being only for one nature of soil, viz. light earth and sand (that for which the table is calculated) must be augmented according to the following table of Vauban; by one, four, five, seven, or nine elevenths of the charge found.

The quantity of gunpowder required to raise a cubic fathom of soil is as follows.

1—For Light earth mixed with sand.11 lb.
2— „ Common earth.....12 „
3— „ Strong sand.....15 „
4— „ Clay or fat earth.....16 „
5— „ Old and good masonry.....18 „
6— „ Rock.....20 „

The following rule is, however, laid down by Belidor, and generally adopted; if it be intended that the mine shall produce its maximum or greatest effect—multiply the line of least resistance, expressed in feet by 300, the product will be the charge in pounds.—*Vauban.*

The horizontal ranges of a body projected with the same force but with different angles of elevation, will be respectively, as double the sines of those angles.

The times of flight of the same body projected with the same force, with different angles of elevation, are to each other, as the sines of the angles of elevation.

The altitude of the curve described by a projectile at any angle of elevation is found by the following proportion; as radius is to tangent of the angle of elevation, so is the range divided by 4 to the altitude.

MOUNTING, AND DISMOUNTING LIGHT FIELD ORDNANCE.

The Detachments are told off, number, take post, take and return small stores, and form up on the same principle as laid down for Standing Gun Drill—vide Section II, from pages 4 to 8 of the Field Battery Exercise.

Articles required.

2 Drag repes, which are laid on the ground, one on each side of, and at 2 paces from the wheels: 1 Claw hammer, which is placed with the drag rope at the left wheel, and 2 pieces of oakum.

DISMOUNTING.

Prepare to dismount the Gun. No. 1 takes out the elevating screw bolt, puts it in the match box;* returns the traversing handspike and hooks the left drag rope on the pintle loop; 2 lays down the spunge two paces to the right, 4 doubles to the limber, and puts away the priming pouch, and 5 places the portfire stock two paces to the left: 2 takes off the right capsquare and 3 the left, and place them inside the spunge and portfire stock: 4, 5, take off linch pins and washers and place them on the capsquares: 1 and 7 man the left, and 6 and 8 the right cheeks of the carriage, 4 and 5 steady the wheels.

Raise the trail. Nos. 1, 6, 7 and 8 raise the trail; 2, 3 bear down upon the gun until its muzzle rests upon the ground. No. 1 then quits the carriage and mans the drag rope at the trail, to prevent the carriage falling to the front as the gun is disengaged from the carriage: 2 fixes the right drag rope by a clove hitch to the neck of the button, and assisted by 3, 4 and 5, disengages the gun from the carriage: 2 then casts off the drag rope, which is coiled up by No. 1: 2 and 3 steady the gun, and 4, 5 man the wheels.

Lower the trail and run back. Nos. 1, 6, 7 and 8 lower the trail; and assisted by 4, 5, run the carriage back four paces, and place the trail gently on the ground: 2, 3 let the gun fall, vent upwards.

Prepare to dismount the Carriage. Nos. 1, 2, 3, 6, 7 and 8 man the carriage; 2, 3 in front, 1, 6, 7 and 8 in rear; 4 at the right and 5 at the left wheel.

Dismount. Nos. 1, 2, 3, 6, 7 and 8 lift the carriage: 4, 5 take off the wheels and lay them on the ground, inside uppermost; the carriage is then lowered till the axles rest on the fellies. No. 1 coils up the drag rope on the trail of the carriage.

Sit down. Nos. 2, 6 and 8 sit on the right; 1, 3 and 7 on the left side of the carriage, and 4, 5 on the wheels.

MOUNTING.

Prepare to mount the carriage. Nos. 1, 2, 3, 6, 7 and 8 man the carriage, 4, 5 the wheels.

* Not necessary with the established pattern Carriage.

Mount. Nos. 1, 2, 3, 6, 7 and 8 lift the carriage, and 4, 5 put on the wheels.

Prepare to mount the Gun. Nos 2 and 3 fix the middle of a drag rope by a clove hitch to the neck of the button, which is manned by 2, 4, 6, 8 on the left, and 1, 3, 5, 7 on the right side; 1 places one of his feet against the muzzle.

Haul. The men haul on the rope, and as the breech is raised 2, 3 quit the rope, go to the cascable and steady the gun: 2 casts off the drag rope, which is coiled up by No. 1—Nos. 1, 6, 7, 8 double up to the trail, and 4, 5 to the wheels.

Run up and raise the trail. The men run up the carriage close to the gun, and No. 1 mans the drag rope at the trail:—6, 7, 8 raise the trail. 4, 5 steady the wheels; 2, 3 push the gun into the trunnion holes; 1 guides the elevating screw into its place and puts in the bolt.*

Lower the trail. The numbers lower the trail to the ground: 2, 3 put on capsquares, 4, 5 the linch pins and washers; 2 takes the spunge, 5 the portfire stock: and 4 doubles to the limber for the priming pouch: 1 coils up the trail drag rope at two paces from the nave of the left wheel, and disengages the handspike: the whole of the numbers then fall into their proper places.

LANDING LIGHT FIELD BATTERY GUNS.

The number of men required is about 15, a launch and a pinnace are required for each gun and limber.

The gun is first to be put in the bottom of the launch, with 2 slings round it, to be in readiness for disembarking, the two gun wheels in the bow resting on their edges, and the carriage midships, the extremities of the axletree resting in two of the boat's rowlocks, which the room taken up by the carriage renders useless.

Six rounds of round shot and canister are to be put in the same boat in the stern sheets.

The other boat takes the ammunition boxes in the bottom, and the wheels and limber, stowed in the same manner as the gun carriage in the launch.

The men are disposed of as follows, 9 men in the launch to mount and serve the gun, 6 in the pinnace, to attend to the limber.

The drag ropes to be with the gun.

In the launch 4 men, Nos. 2, 3, 4, 5 are in the bow, and 5 men 1, 6, 7, 8, 9 in the after part of the boat.

The moment the head of the launch touches the beach the 4 men jump over the bow, and place the two wheels on the ground, above the wash of the sea; they return and haul in the boat which is then much lightened keeping her head in.

The 4 men in the after part of the boat jump over the side, the water being generally about knee-deep, and with the assistance of the 4 midship boatmen, pass

* Not necessary with the established pattern Carriage.

2 bars through the drag ropes that have been put round the carriage, so as to form loops.

Six or eight men (even numbers on the right) will then raise the carriage and walk up to the wheels, assisted by two other men. The wheels being upright ready for fixing 2—4 the right, and 3—5 the left wheel; while the linch pins and *washers* are fitting by 2 and 3, the remainder of the men return for the gun, pass the bars through the slings, and walk it over the bow of the boat to the carriage; they then place it on its muzzle, and mount in the usual way.

The ammunition during the time is getting ready, and the two stroke oars are kept out, to keep the boat's head to the beach. As the gun and carriage are carried over the boat's bow, the movement would be retarded by allowing her to fall broadside on the shore.

The gun should be ready for action in two minutes from the time of the boat's touching the beach.

The limber will be landed much in the same order; but not until it is seen that the guns can keep their ground.

In embarking, the reverse of this system, must be followed.

The system of mounting and dismounting guns and carriages should be frequently practised on the quarter deck in fine weather.

Ammunition waggons, follow the limbers.

MISCELLANEOUS.

Horses on Board Ship.—The front upright stanchions require to be very strong and well put up or they are constantly carried away by the horses. The horses may stand as close as possible to each other, but there ought to be a vacant stall to every 3 or 4 horses, otherwise the labour of shifting when a horse falls is excessive. The front bar which is pinned to the front stanchions should not extend over more than two or three stalls (instead of 5 or 6, as it usually does) being then much easier to unpin, this arrangement also obviates the inconvenience of partially loosening so many horses to get at one.

To every 3d or 4th stall there should be cleats fitted to the deck *above*, so that a horse not able to stand may be partially slung, and supported;—Heel-ropes will do for this very well. Gunny should be fitted to the front bars, for horses to eat hay from, with strings attached (when in use) to the deck above. Lanterns with *wax candles* are supplied but they are useless. The wax between decks melts immediately; oil and cottons should be supplied instead. If horses cannot be got at to clean (from rolling; bad weather, &c.) washing the eyes and nostrils is found of great benefit. Horses should above all be kept as low as possible on Board ship, half the allowance of gram is too much, half a seer of bran daily keeps their bowels regular. Nitre may be given to induce staling, but they sweat so much that this is of rare occurrence in any quantity.

The following are the weights, carried by the detachment riding, and off horses in the Madras Horse Artillery in marching order with a man weighing 11 stone.

Detachment horse,.....between 16 and 17 stone.
Riding pole „ .....nearly 20 stone.
Off „ „ .....nearly 6 stone.
Front, or centre riding horse...18 stone.
Front, or centre Off „ ..nearly 5 stone.

The average weight of a Horse in India is 8½ cwt; and occupies when standing at his pickets a space of 27 square feet, or 3 feet in breadth and 9 feet in depth.

Rate of pace of Cavalry and Horse Artillery in India.

Walk.....	3½	miles in one hour, or 1	mile in	16	minutes.
Trot.....	7½	„ „ „ or 1	„	8	„
Manœuvring gallop	11	„ „ „ or 1	„	5	„
Gallop out.....	20	„ „ „ or 1	„	3	„
Cavalry charge.....	24	„ „ „ or 1	„	2½	„

Rate of march of Infantry.

Slow	step	75	paces in a minute	(62 yds.)	or 2	miles	230	yds.	in one hour.
Quick	step	108	„ „ „	(90 „)	or 3	„	120	„	„	„	„
Double	step	150	„ „ „	(125 „)	or 4	„	460	„	„	„	„

Paces may readily be converted into yards and vice versa, by the following method:—From the given number of paces deduct ⅛, and the remainder will be the same distance in yards. To the given number of yards add ⅛, and the sum will be the same distances in paces.

A Basket Boat, 18 feet diameter, 3½ feet deep will carry 60 cwt. One of 10½ feet diameter and 2½ feet deep will carry 30 cwt. and with 10, or 12, five gallon casks lashed around, it will bear 50 cwt.

Fords for Cavalry should not be more than 4 feet 4 inches in depth.
„ „ Infantry should not be more than 3 feet 3 inches in depth.
„ „ Artillery should not be more than 2½ feet in depth.

Infantry may cross by a ford 4 feet deep by holding on to the horses of the Cavalry. Artillery may cross a ford 4 feet deep by taking out the powder. Fords are generally to be found above or below a bend, and in an oblique direction. Notched poles should be fixed to mark its direction and height of water.

Table of Effects upon Bodies by Heat.

	Fahrent.		Fahrent.
Cast iron, thoroughly smelted.....	2754°	Quicksilver, boils.....	630
Fine gold, melts.....	1983	Linseed oil, boils.....	600
Fine silver, melts.....	1850	Lead, melts.....	594
Copper, melts.....	2160	Bismuth, melts.....	476
Brass, melts.....	1900	Tin, melts.....	421
Red heat, visible by day.....	1077	Tin and bismuth, equal parts, melt.	283
Iron, red hot in twilight.....	884	Tin 3 parts, bismuth 5, and lead 2,	
Common fire.....	790	melt.....	212
Iron, bright red in the dark.....	752	Alcohol, boils.....	174
Zinc, melts.....	740	Ether, boils.....	98

RULES FOR CALCULATING THE LENGTHS OF FUZES AT DIFFERENT RANGES.

Given the Range, to find the length of Fuze, for the following Pieces of Ordnance.

24 Pounder Howitzer—for Common Shell and Spherical Case.

RULE.—From the number of hundred yards in the range deduct three, and the remainder will be the length of Fuze required in tenths of an Inch.

Example.—To find the length of Fuze for a range of 900 yards.

9—3=6 tenths, length of Fuze required.

9 Pounder Gun.

RULE.—When the range exceeds 800 yards—From the number of hundred yards in the range deduct five, and to the remainder add ½ tenth, for length of Fuze required.

Example.—For a range of 1300 yards.

13—5+½=8½ tenths.

For every intermediate 25 yards between hundreds add ¼ tenth to the above.

Thus—24 Pounder Howitzer—975 yards range 9—3=6, add ¾ for 75 yards gives 6¾ tenths, length of Fuze required.

12 Pounder Howitzer—For Common Shell only.

RULE.—From the number of hundred yards in the range deduct three, and to the remainder add ¼ tenth for length of Fuze required.

Thus for a range of 1000 yards.

10—3+¼=7¼ tenths, length of Fuze required.

6 Pounder Gun.

RULE.—From the number of hundred yards in the Range deduct four for the length of Fuze required.

Thus for a range of 900 yards.

9—4=5 tenths, length of Fuze required.

For every intermediate 25 yards between hundreds add ¼ tenth to the above.

8 and 10 inch Howitzers—with Service Charges of 4 lbs. and 7 lbs. respectively.

RULE.—To the number of hundred yards in the range add one for the length of Fuze in tenths of an inch.

Thus—for a Range of 1900 yards.

19+1=20 tenths or 2 inches, length of Fuze required.

TABLE OF THE FLIGHT OF SHELLS, AT VARIOUS DISTANCES AND ELEVATIONS.

RULE:—The time of flight in seconds is equal to one-fourth the square root of the product of the range in feet, multiplied by the natural tangent of the angle of elevation.

Ranges.	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°
Yards.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.
150	2¼	2½	3¼	3½	4	4½	4¾	5¼	5¾	6¼	7	7¾	8¾	10¼	12¾
200	2½	3¼	3¾	4½	4¾	5	5½	6	6¾	7¼	8	9	10¼	11¾	14½
250	2¾	3½	4¼	4¾	5¼	5¾	6¼	6¾	7½	8¼	9	10	11½	13¼	16½
300	3¼	3¾	4½	5	5¾	6¼	6¾	7½	8¼	9	10	11	12½	14¼	17¾
350	3½	4¼	4¾	5½	6¼	6¾	7½	8	8¾	9¾	10¾	11¾	13¾	15¾	19¼
400	3¾	4½	5¼	6	6½	7¼	8	8¾	9½	10¼	11½	12¾	14¾	16¾	20½
450	3¾	4¾	5½	6¼	7	7¾	8½	9¼	10	11	12	13½	15¼	17¾	21¾
500	4	5	5¾	6½	7¼	8	8¾	9¾	10½	11½	12¾	14¼	16	18¾	23
550	4¼	5¼	6	7	7¾	8½	9¼	10¼	11	12¼	13¼	14¾	16¾	19½	24½
600	4½	5½	6¼	7¼	8	8¾	9¾	10¾	11½	12¾	14	15¾	17¾	20¾	25¾
650	4¾	5¾	6¾	7½	8¼	9¼	10	11	12	13¼	14½	16¼	18¼	21½	26¼
700	4¾	6	7	7¾	8¾	9½	10½	11½	12½	13¾	15	16¾	19	22¼	27½
750	5	6	7¼	8	9	10	10¾	11¾	13	14¼	15¼	17¼	19¾	23	28¼
800	5¼	6¼	7½	8¼	9¼	10¾	11¼	12¼	13¼	14½	16	18	20¼	23¾	29¼
850	5¼	6½	7¼	8½	9½	10½	11½	12½	13¾	15	16½	18½	21	24½	30
900	5½	6¾	7¾	8¾	9¾	10¾	12	13	14¼	15½	17	19	21½	25	31
950	5½	7	8	9	10¼	11¼	12¼	13¼	14½	16	17½	19½	22	25¾	31¾
1000	5¾	7	8¼	9¼	10¼	11½	12½	13¾	15	16¼	18	20	22¾	26½	32½
1050	5¾	7¼	8½	9½	10¾	11¾	12¾	14	15½	16¾	18½	20½	23½	27	33½
1100	6	7½	8¾	9¾	11	12	13¼	14½	15¾	17½	19	21	23¾	27¾	34½
1150	6¼	7½	8¾	10	11¼	12¼	13½	14¾	16	17½	19½	21½	24½	28½	35
1200	6¼	7¾	9	10¼	11½	12½	13¾	15	16¼	18	19¾	22	24¾	29	35¾
1250	6½	8	9¼	10½	11½	12¾	14	15¼	16¾	18¼	20½	22½	25½	29½	36¾
1300	6½	8	9½	10¾	11¾	13	14¼	15½	17	18¾	20¾	22¾	25¾	30½	37¾
1350	6¾	8¼	9½	10¾	12	13¼	14½	16	17¼	19	21	23¼	26¼	30¾	38
1400	6¾	8¼	9¾	11	12¼	13½	14¾	16¼	17¾	19½	21¼	23¾	26¾	31¼	38¾
1450	7	8½	10	11¼	12½	13¾	15	16½	18	19¾	21¾	24¼	27¼	31¾	39¼
1500	7	8¾	10	11½	12¾	14	15¼	16¾	18¼	20	22	24½	27¾	32¼	40

The distances at which Artillery usually fire the various projectiles are,—**Spherical Case,** from 650 to 1400 yards.—**Round Shot,** from 350 to 1400 yards and upwards.—**Canister Shot,** at a distance not exceeding 350 yards.—**Double Charges of Canister Shot,** used from 150 yards and within that distance.—Artillery can come into action when at exercise in the Field and fire a round in half a minute.—Artillery can fire in one minute 2 rounds of **Round Shot,** or 3 of **Canister** or 5 to 6 rounds of **Blank Cartridge.**

NATURAL SINES, TANGENTS, AND SECANTS.

Deg.	Sine.	Cosine.	Tangent.	Cotangent.	Secant.	Cosecant.	Deg.
0	·000000	1·000000	·000000	Infinite.	1·000000	Infinite.	90
1	·017462	·999848	·017455	57·289962	1·000152	57·298688	89
2	·034899	·999391	·034921	28·636253	1·000609	28·653708	88
3	·052336	·998630	·052408	19·081137	1·001372	19·107323	87
4	·069756	·997564	·069927	14·300666	1·002442	14·335587	86
5	·087156	·996195	·087489	11·430052	1·003820	11·473713	85
6	·104528	·994522	·105104	9·514364	1·005508	9·566772	84
7	·121869	·992546	·122785	8·144346	1·007510	8·205509	83
8	·139173	·990268	·140541	7·115370	1·009828	7·185296	82
9	·156434	·987688	·158384	6·313751	1·012465	6·392453	81
10	·173648	·984808	·176327	5·671282	1·015427	5·758770	80
11	·190809	·981627	·194380	5·144554	1·018717	5·240843	79
12	·207912	·978148	·212557	4·704630	1·022341	4·809734	78
13	·224951	·974370	·230868	4·331476	1·026304	4·445411	77
14	·241922	·970296	·249328	4·010781	1·030614	4·133565	76
15	·258819	·965926	·267949	3·732051	1·035276	3·863703	75
16	·275637	·961262	·286745	3·487414	1·040299	3·627955	74
17	·292372	·956305	·305731	3·270853	1·045692	3·420304	73
18	·309017	·951057	·324920	3·077683	1·051462	3·236068	72
19	·325568	·945519	·344328	2·904211	1·057621	3·071553	71
20	·342020	·939693	·363970	2·747477	1·064178	2·923804	70
21	·358368	·933580	·383864	2·605089	1·071145	2·790428	69
22	·374607	·927184	·404026	2·475087	1·078535	2·669467	68
23	·390731	·920505	·424475	2·355852	1·086360	2·559305	67
24	·406737	·913545	·445229	2·246037	1·094636	2·458593	66
25	·422618	·906308	·466308	2·144507	1·103378	2·366202	65
26	·438371	·898794	·487733	2·050304	1·112602	2·281172	64
27	·453990	·891007	·509525	1·962610	1·122326	2·202689	63
28	·469472	·882948	·531709	1·880726	1·132570	2·130054	62
29	·484810	·874620	·554309	1·804048	1·143354	2·062665	61
30	·500000	·866025	·577350	1·732051	1·154700	2·000000	60
31	·515038	·857167	·600861	1·664279	1·166633	1·941604	59
32	·529919	·848048	·624869	1·600334	1·179178	1·887080	58
33	·544639	·838671	·649408	1·539865	1·192363	1·836078	57
34	·559193	·829038	·674508	1·482561	1·206218	1·778292	56
35	·573576	·819152	·700207	1·428148	1·220775	1·743447	55
36	·587785	·809017	·726542	1·376382	1·236068	1·701302	54
37	·601815	·798636	·753554	1·327045	1·252136	1·661640	53
38	·615661	·788011	·781286	1·279942	1·269018	1·624269	52
39	·629320	·777146	·809784	1·234897	1·286760	1·589016	51
40	·642788	·766044	·839100	1·191754	1·305407	1·555724	50
41	·656059	·754710	·869287	1·150368	1·325013	1·524253	49
42	·669131	·743145	·900404	1·110612	1·345633	1·494476	48
43	·681998	·731354	·932515	1·072369	1·367327	1·466279	47
44	·694658	·719340	·965689	1·035530	1·390164	1·439556	46
45	·707107	·707107	1·000000	1·000000	1·414214	1·414214	45
Deg.	Cosine.	Sine.	Cotangent	Tangent.	Cosecant.	Secant.	Deg.

TABLES OF SQUARES, CUBES AND ROOTS.

Number.	Square.	Cube.	Square Root.	Cube Root.	Number.	Square.	Cube.	Square Root.	Cube Root.
1	1	1	1·0000000	1·000000	26	676	17576	5·0990195	2·962496
2	4	8	1·4142136	1·259921	27	729	19683	5·1961524	3·000000
3	9	27	1·7320508	1·442250	28	784	21952	5·2915026	3·036589
4	16	64	2·0000000	1·587401	29	841	24389	5·3851648	3·072317
5	25	125	2·2360680	1·709976	30	900	27000	5·4772256	3·107232
6	36	216	2·4494897	1·817121	31	961	29791	5·5677644	3·141381
7	49	343	2·6457513	1·912933	32	1024	32768	5·6568542	3·174802
8	64	512	2·8284271	2·000000	33	1089	35937	5·7445626	3·207534
9	81	729	3·0000000	2·080084	34	1156	39304	5·8309519	3·239612
10	100	1000	3·1622777	2·154435	35	1225	42875	5·9160798	3·271066
11	121	1331	3·3166248	2·223980	36	1296	46656	6·0000000	3·301927
12	144	1728	3·4641016	2·289428	37	1369	50653	6·0827625	3·332222
13	169	2197	3·6055513	2·351335	38	1444	54872	6·1644140	3·361975
14	196	2744	3·7416574	2·410142	39	1521	59319	6·2449980	3·391211
15	225	3375	3·8729833	2·466212	40	1600	64000	6·3245553	3·419952
16	256	4096	4·0000000	2·519842	41	1681	68921	6·4031242	3·448217
17	289	4913	4·1231056	2·571282	42	1764	74088	6·4807407	3·476027
18	324	5832	4·2426407	2·620741	43	1849	79507	6·5574385	3·503398
19	361	6859	4·3588989	2·668402	44	1936	85184	6·6332496	3·530348
20	400	8000	4·4721360	2·714418	45	2025	91125	6·7082039	3·556893
21	441	9261	4·5825757	2·758923	46	2116	97336	6·7823300	3·583048
22	484	10648	4·6904158	2·802039	47	2209	103823	6·8556546	3·608826
23	529	12167	4·7958315	2·843867	48	2304	110592	6·9282032	3·634241
24	576	13824	4·8989795	2·884499	49	2401	117649	7·0000000	3·659306
25	625	15625	5·0000000	2·924018	50	2500	125000	7·0710678	3·684031

Number.	Square.	Cube.	Square Root.	Cube Root.	Number.	Square.	Cube.	Square Root.	Cube Root.
51	2601	132651	7·1414284	3·708430	76	5776	438976	8·7177979	4·235824
52	2704	140608	7·2111026	3·732511	77	5929	456533	8·7749644	4·254321
53	2809	148877	7·2801099	3·756286	78	6084	474552	8·8317609	4·272659
54	2916	157464	7·3484692	3·779763	79	6241	493039	8·8881944	4·290841
55	3025	166375	7·4161985	3·802953	80	6400	512000	8·9442719	4·308870
56	3136	175616	7·4893148	3·825862	81	6561	531441	9·0000000	4·326749
57	3249	185193	7·5498344	3·848501	82	6724	551368	9·0553851	4·344481
58	3364	195112	7·6157731	3·870877	83	6889	571787	9·1104336	4·362071
59	3481	205379	7·6811457	3·892996	84	7056	592704	9·1651514	4·379519
60	3600	216000	7.7459667	3·914867	85	7225	614125	9 2195445	4·396830
61	3721	226981	7·8102497	3·936497	86	7396	636056	9·2736185	4·414005
62	3844	238328	7·8740079	3·957892	87	7569	658503	9·3273791	4·431047
63	3969	250047	7·9372539	3·979075	88	7744	681472	9·3808315	4·447960
64	4096	262144	8·0000000	4·000000	89	7921	704969	9·4339811	4·464745
65	4225	274625	8·0622577	4·020726	90	8100	729000	9·4868330	4·481405
66	4356	287496	8·1240384	4·041240	91	8281	753571	9 5393920	4·497941
67	4189	300763	8·1853528	4·061548	92	8464	778688	9·5916630	4·514357
68	4624	314432	8·2462113	4·081656	93	8649	804357	9·6436508	4·530655
69	4761	328509	8·3066239	4·101566	94	8836	830584	9·6953597	4·546836
70	4900	343000	8·3666003	4·121285	95	9025	857375	9·7467943	4·562903
71	5041	357911	8·4261498	4·140818	96	9216	884736	9·7979590	4·578857
72	5184	373248	8·4852814	4·160168	97	9409	912673	9·8488578	4·594701
73	5329	389017	8·5440037	4·179339	98	9604	941192	9·8994949	4·610436
74	5476	405224	8·6023253	4·198336	99	9801	970299	9·9498744	4·626065
75	5625	421875	8·6602540	4·217163	100	10000	1000000	10·0000000	4·641589

DECIMAL FRACTIONS CORRESPONDING TO VULGAR FRACTION

In the following Tables, the Decimal Fractions are Reciprocals of the D
nators of those opposite to them; and their Product is = Unity.

To find the Decimal corresponding to a Fraction having a higher Nu
than 1, multiply the Decimal opposite to the given Denominator, by th
Numerator. Thus, the Decimal corresponding to $\frac{15}{64}$ being ·015625, the L
to $\frac{15}{64}$ will be ·015625 × 15 = ·234375.

Fraction or Number.	Decimal or Reciprocal.	Fraction or Number.	Decimal or Reciprocal.	Fraction or Number.	Decimal or Reciprocal.	Fraction or Number.	De or pr
1-2	·5	1-37	·027027027	1-72	·013888889	1-107	·00
1-3	·333333333	1-38	·026315789	1-73	·01369863	1-108	·00
1-4	·25	1-39	·025641026	1-74	·013513514	1-109	·00
1-5	·2	1-40	·025	1-75	·013333333	1-110	·00
1-6	·166666667	1-41	·024390244	1-76	·013157895	1-111	·00
1-7	·142857143	1-42	·02380952	1-77	·012987013	1-112	·00
1-8	·125	1-43	·023255814	1-78	·012820513	1-113	·00
1-9	·111111111	1-44	·022727273	1-79	·012658228	1-114	·00
1-10	·1	1-45	·022222222	1-80	·0125	1-115	00
1-11	·090909091	1-46	·02173913	1-81	·012345679	1-116	·00
1-12	·083333333	1-47	·0212766	1-82	·012195122	1-117	·00
1-13	·076923077	1-48	·020833333	1-83	·012048193	1-118	·00
1-14	·071428571	1-49	·020408163	1-84	·011904762	1-119	·00
1-15	·066666667	1-50	·02	1-85	·011764706	1-120	·00
1-16	·0625	1-51	·019607843	1-86	·011627907	1-121	·00
1-17	·058823529	1-52	·019230769	1-87	·011494253	1-122	·00
1-18	·055555556	1-53	·018867925	1 88	·01136363	1-123	·00
1-19	·052631579	1-54	·018518519	1-89	·01123595	1-124	·00
1-20	·05	1-55	·018181818	1-90	·011111111	1-125	·00
1-21	·047619048	1-56	·017857143	1-91	·010989011	1-126	·00
1-22	·045454545	1-57	·01754386	1-92	·010869565	1-127	·00
1-23	·043478261	1-58	·017241379	1-93	·010752688	1-128	·00
1-24	·041666667	1-59	·016949153	1-94	010638298	1-129	·00
1-25	·04	1-60	·016666667	1-95	·010526316	1-130	·00
1-26	·038461538	1-61	·016393443	1-96	·010416667	1-131	·00
1-27	·037037037	1-62	·016129032	1-97	·010309278	1-132	·00
1-28	·035714286	1-63	·015873016	1-98	·010204082	1-133	·00
1-29	·034482759	1-64	·015625	1-99	·01010101	1-134	·00
1-30	·033333333	1-65	·015384615	1-100	·01	1-135	·00
1-31	·032258065	1-66	·015151515	1-101	·00990099	1-136	·00
1-32	·03125	1-67	·014925373	1-102	·009803922	1-137	·00
1-33	·030303030	1-68	·014705882	1-103	·009708738	1-138	·00
1-34	·029411765	1-69	·014492754	1-104	009615385	1-139	·00
1-35	·028571429	1-70	·014285714	1-105	·00952381	1-140	·00
1-36	·027777778	1-71	·014084517	1-106	·009433962		

Avoirdupois Weight.

	1 Drac. =	27·34375 grs.
16 Drachms	= 1 Oun. =	437·5 „
16 Ounces	= 1 lb. =	7000 „
28 Pounds	= 1 Qr. =	196000 „
4 qrs. or 112 lbs	= 1 cwt. =	784000 „
20 cwt.	= 1 Ton =	15680000 „
N.B. 1 lb. Avoir.	= 1 lb. 2ozs. 11dwts. 16 „ Troy.	
1 lb. Avoir.	= 1 lb. 2ozs. 4drs 2scrups. Apothy.	
1 lb. Troy.	= 13 ozs. 2drs. 17·8125grs. Avoir.	
175 lbs. „	= 144 lbs. Avoirdupois.	
175 ozs. „	= 192 ozs. „	

Superficial Measure.

144 Square Inches	= 1 Square Foot.
9 Square Feet	= 1 Square Yard.
30¼ Square Yards or 272¼ Square Ft.	= 1 Square rod, pole or Perch.
40 Poles	= 1 Rood,
4 Roods	= 1 Acre,
640 Acres	= 1 Square Mile.

Solid Measure.

1728 Solid Inches	= 1 Cubic Foot.
27 Solid Feet	= 1 Cubic Yard
40 Feet of rough Timber or 50 Feet of Hewn Timber	= 1 Ton or Load.
42 Cubic Feet	= 1 Ton of Shipping.

Liquid Measure.

4 Gills	= 1 Pint.
2 Pints	= 1 Quart.
4 Quarts	= 1 Gallon.
36 Gallons	= 1 Barrel.

Lineal Measure.

10 Tenths	= 1 Inch.
4 Inches	= 1 Hand.
12 „	= 1 Foot.
30 „	= 1 Pace.
3 Feet	= 1 Yard.
2 Yards	= 1 Fathom.
220 „	= 1 Furlong.
8 Furlongs or 1760 Yards	= 1 Mile.

Indian Measure.

8 Ollocks	= 1 Measure (Puddy.)
8 Measures	= 1 Merkall.
5 Merkalls	= 1 Parah.

N. B. 20 Ollocks are equal to 1 English Gallon.

Land Measure.

60 Feet long and 40 Feet Broad make one Ground, containing 2400 Square feet.
24 Grounds make 1 Cawnie.
484 Cawnies 1 Square Mile.
The Indian Cawnie is in proportion to the English Acre as 1 1·3223, or as 121 to 160.

Table to facilitate conversion from Europe into Country weights.

lbs. Avoir.		Pollums.
¼	=	3·24074
½	=	6·48148
¾	=	9·72222
1	=	12·96296
5	= 1 viss	24·8148
10	= 3 „	9·6296
20	= 6 „	19·2592
25	= 1 maund 0 viss	4·074

Table to facilitate conversions from Country into Europe weights.

	lbs.	ozs.	drs.
1 Maund.	24	10	15·542½
5 „	123	6	13·71½
10 „	246	13	11·428½
20 „ (1 candy)	493	11	6·857½
1 Viss	2	1	5·942½
5 „	15	6	13·713½
8 „ (1 maund)	24	10	15·542½
1 Pollum.	0	1	3·748½
5 „	0	6	2·742½
10 „	0	12	5·483½
20 „	1	8	10·967½
40 „ (1 Viss)	3	1	5·942½
1 Tola	0	0	6·582½
3 „ (1 Pol.)	0	1	3·748½

French Weights and Measures.

Weights.

Gramme	15·434 grains.
Decigramme	1·5434 „
Centigramme	0·1543 „
Milligramme	0·0154 „
Decagramme	154·34 „
Hectogramme	3·2154 oz Troy.
or	3·527 oz. Avoird.
Kilogramme	2·6795 lb. Troy.
or	2·2048 lb. Avoird.
Myriagramme	26·795 lb. Troy.
	22·048 lb. Avoird.
Quintal	1 cwt. 3 qrs. 24½ lb.
Millier or Bar,	16 cwt. 3 qrs. 12 lb.

Measures of Capacity.

	C. Ins.
Millilitre	·06103
Centilitre	·61028
Decilitre	6·10279
Litre, or cubic decimetre.	61·02791
Decalitre	610·27900
Hectolitre	6102·79000
Kylolitre	61027·90000
Myrialitre	610279·00000

1 litre is nearly 2¼ wine pints.
1 kilolitre 1 tun 12¼ wine gallons.
1 stere, or cubic metre 35·3171.

Measures of Length.

	Eng. Feet.
Metre	3·281
„ French feet	3·07844
Millimetre	·03937
Centimetre	·39371
Decimetre	3·93708
Metre	39·37079
Decametre	393·70790
Hectometre	3937·07900
Kilometre	39370·79000
Myriametre	393707·90000

8 Kilometres are nearly 5 miles.
1 Inch is ·0254 metre.
100 feet are nearly 30·5 metres.

Of Superficies.

Are, or square decameter	119·6 sq. yds.
Deciare	11·960 „
Centiare	10·764 sq. feet
Milliare	155·00 sq. inch
Decare	1196·0 sq. yds.
Hectare	2·4712 acres.

Of Solidity.

Stere, or cubic metre	35·3171 cub. feet.
Decistere	3·5317 „
Centistere	610·28 cub. ins.
Millistere	61·028 „
Decastere	13·080 cub. yds.
Hectostere	130·80 „

Maximum Density of Water, 42 degrees Fahrenheit.

1 Cubic foot of water		6¼ Imperial gallons.
1 Cylindric foot „	about	5 „
1 Cubic foot	weighs	62·5 lb. avoirdupois.
1 Cylindric „	„	49·1
1 Lineal (1 inch square)	„	·434
12·2 Imperial gallons	„	1 cwt.
224 „	„	1 Ton.
1·8 Cubic feet	„	1 cwt.
35·84 „	„	1 Ton.

SCALE OF PAY OF EUROPEAN WARRANT AND NON-COMMISSIONED RANK AND FILE HORSE ARTILLERY.

Europeans.	In Garrison.			In the Field.			Batta.		
Troop Quarter Masters	161	0	0	191	7	0			
Riding Master	147	7	0	192	14	0			
Regimental Serjeant Major	49	6	10	50	15	10			
Regimental Quarter Master Serjeant	43	6	10	44	15	10			
Troop Serjeant Majors	39	3	4	40	12	4			
Troop Quarter Master Serjeants	39	3	4	40	12	4			
Serjeants	27	6	4	28	15	4			
Corporals — After 14 Years Service	23	13	9	25	6	9			
Corporals — Under 14 „ „	21	6	0	22	15	0			
Bombardiers — After 14 „ „	21	13	9	23	6	9			
Bombardiers — Under 14 „ „	19	6	0	20	15	0			
Trumpeters	19	9	8	21	2	8			
Farriers — After 14 Years Service	15	5	5	16	14	5			
Farriers — Under 14 „ „	12	13	8	14	6	8			
Gunners — After 14 „ „	15	5	5	16	14	5			
Gunners — Under 14 „ „	12	13	8	14	6	8			
NOTE.—For Good Conduct Pay vide Foot Artillery Tables.									
Natives.									
Subadars — 1st Class or after 10 Years Service.	129	0	0	0	0	0	30	0	0
Subadars — 2d „ or „ 6 „ „	111	8	0	0	0	0	30	0	0
Subadars — 3d „ or under 6 „ „	101	0	0	0	0	0	30	0	0
Jemadars	32	0	0	0	0	0	8	0	0
Havildars	20	0	0	0	0	0	5	0	0
Naigues	16	0	0	0	0	0	4	0	4
Trumpeters	16	0	0	0	0	0	4	0	0
Farriers — 1st Class or after 17 Years Service.	18	13	10	0	0	0	4	10	10
Farriers — 2d „ or under 17 „ „	16	10	4	0	0	0	4	10	10
Troopers	9	0	0	0	0	0	1	8	0
Puckallies	10	11	10	0	0	0	1	8	0
Artificers.									
Maistry — Per each Troop with a Complete Battery.	14	0	0	0	0	0	1	8	0
Carpenters — Per each Troop with a Complete Battery.	10	2	4	0	0	0	1	8	0
Armourers — Per each Troop with a Complete Battery.	10	2	4	0	0	0	1	8	0
Smiths — Per each Troop with a Complete Battery.	10	2	4	0	0	0	1	8	0
Hammermen — Per each Troop with a Complete Battery.	7	9	9	0	0	0	1	8	0
Bellows Boys — Per each Troop with a Complete Battery.	2	8	7	0	0	0	1	2	11
Chucklers — Per each Troop with a Complete Battery.	7	9	9	0	0	0	1	8	0
Horsekeepers.									
Chowdries	8	12	0	0	0	0	1	8	0
Horsekeepers	5	4	0	0	0	0	1	8	0
Grasscutters	4	0	0	0	0	0	1	8	0

European Horse Artillery Articles.	Number of each constituting.		
	Field Kit.	Reserve Kit.	Total or Full Kit.
Helmet	0	1	1
„ Oil Skin Cover	0	1	1
Forage Cap	1	0	1
Dress Jacket	0	1	1
Undress Jacket (Cloth)	0	1	1
Fatigue Jacket (Flannel)	1	0	1
Girdles	1	0	1
Woollen Trowsers, pairs	1	0	1
Cloak	1	0	1
White Trowsers, pairs	0	4	4
Banyan „ „	2	0	2
White Shirts	0	6	6
Banyan „	2	0	2
Flannel Waistcoats	2	0	2
White Helmet Cover	0	1	1
White Forage Cap Covers	1	1	2
Socks (2 pairs worsted, 2 cotton,)	2	2	4
Braces	1	0	1
Towels	1	1	2
Holdall containing	1	0	1
Button Stick and Brush	1	0	1
Knife, Fork and Spoon	1	0	1
Hair Comb and small tooth Comb	1	0	1
Hair Brush	1	0	1
Razor, Soap Brush, and Soap	1	0	1
Needles, Thread, thimble, buttons &c.	due portion.	0	due portion
Clothes Brush	0	1	1
Shoe do,	0	2	2
Spunge	1	0	1
Boots and Spurs, pairs	1	0	1
Shoes and Clasps	1	1	2
Marking Stamp	0	1	1
Mess Tin and Cover	1	0	1
Regimental Carpet	1	0	1
Quilt	1	0	1
Account Book	1	0	1
Bible and Prayer Book	1	0	1
Gloves	1	0	1

The above allotments of Articles constituting the "Field" and "Reserve" Ki are intended for ordinary occasions. The proportions can be varied under var ng circumstances, at the discretion of Commanding Officers.

SCALE OF PAY OF EUROPEAN NON-COMMISSIONED RANK AND FILE FOOT ARTILLERY.

	In Garrison.			In Field.			Batta.		
Serjeant Major	46	14	10	48	7	10			
Quarter Master Serjeant	40	14	10	42	7	10			
Staff Brigade Serjeants	32	6	0	33	15	5			
Serjeants	24	14	4	26	7	4			
Corporals — After 14 Years Service	22	13	9	24	6	9			
Corporals — Under 14 „ „	20	6	0	21	15	0			
Bombardiers — After 14 „ „	20	13	9	22	6	9			
Bombardiers — Under 14 „ „	18	6	0	19	15	0			
Buglers	16	9	8	18	2	8			
Half Pay Buglers	8	4	10	9	1	4			
Gunners — After 14 Years Service	14	11	3	16	4	3			
Gunners — Under 14 „ „	12	3	6	13	12	6			
Puckallies	10	11	10	0	0	0	1	8	0
Gun Lascars.									
Subadars — 1st Class or after 10 Years Service.	42	0	0	0	0	0	7	1	7
Subadars — 2d „ or „ 6 „ „	31	8	0	0	0	0	7	1	7
Subadars — 3d „ or under 6 „ „	24	8	0	0	0	0	7	1	7
Jemadars	17	8	0	0	0	0	3	8	10
Havildars	9	13	4	0	0	0	3	8	10
Gun Lascars — 1st Class after 20 Years Service	9	13	4	0	0	0	2	5	10
Gun Lascars — 2nd „ „ 16 „ „	8	13	4	0	0	0	2	5	10
Gun Lascars — 3rd „ under 16 „ „	7	13	4	0	0	0	2	5	10
Gun Lascars — 4th entertained subsequent to 30th April 1837	7	13	4	0	0	0	1	8	0
Gun Lascars — 5th Class „ to 12th November 1839	7	0	0	0	0	0	1	8	0
Puckallies	10	11	10	0	0	0	1	8	0
Bheasties	7	0	0	0	0	0	1	8	0
Lascar Boys	3	8	0	0	0	0	0	0	0
Artificers.									
Maistry — Per each Company with a Complete Battery.	14	0	0	0	0	0	1	8	0
Armourers — Per each Company with a Complete Battery.	10	2	4	0	0	0	1	8	0
Carpenters — Per each Company with a Complete Battery.	10	2	4	0	0	0	1	8	0
Smiths — Per each Company with a Complete Battery.	10	2	4	0	0	0	1	8	0
Hammermen — Per each Company with a Complete Battery.	7	9	9	0	0	0	1	8	0
Bellows Boys — Per each Company with a Complete Battery.	2	8	7	0	0	0	1	2	11
Chucklers — Per each Company with a Complete Battery.	7	9	9	0	0	0	1	8	0

The following are the rates of G. C. Pay received in addition to the Pay included in the preceding Table by Corporals, Bombardiers, Buglers and Gunners enlisted on or after the 1st September 1886 and such soldiers as have enlisted prior to that date who have relinquished their claim to Length of Service Pay.

				In Garrison.			In Field.			Batta.		
After	5	Years		1	3	11						
„	10	„		2	7	9						
„	15	„		3	11	8						
* „	20	„		4	15	6						
* „	25	„		6	3	5						
* „	30	„		7	7	3						
European Woman				5	0	0						
East Indian		„		3	8	0						
Child				2	8	0						

Ration Money.

There is Annas 3 and pice 4 stopped from the Soldiers pay daily for rations; if the daily cost to Government does not amount to the sum stopped, the soldier receives the difference back monthly—which is drawn by Bill on the Commissariat Officer of the Station.

Karkhana.

Bullock Serjeant exclusive of Pay of Rank	10	0	0	0	0	0	0	0
Darogah	17	0	0	0	0	0	1	8	0
Choudry	12	0	0	0	0	0	1	8	0
Drivers	6	8	0	0	0	0	1	8	0

N. B.—Drivers receive additional G. C. Pay of 1 Rupee each after 16 Years Service, and 2 Rupees additional after 20 Years Service.

Rupees 3-8-0 per mensem is allowed for each Karkhana, for Stationery,

Rice Money.

If the 3rd sort of Rice should be under 30 seers per Rupee, the Lascars and Drivers receive the difference which is drawn by Bill on the Paymaster of the Station Monthly, at the rate of 2 Seers per man per diem.

Scale of Rations Supplied daily to the European Troops.

1 lb. of Bread,
1 lb. of Meat.
4 oz. of Rice
2½ oz. of Sugar,
½ oz. of Tea,
1 oz. of Salt,
1 lb. of Vegetables,
3 lbs. of Firewood.

* N. B.—Men whose names have not been entered in the Regimental Defaulter Book for the last 16 years will receive Good Conduct Pay 2 years earlier, that is to say instead of at 20, 25, and 30 years service, they will receive it at 18, 23 and 28.

Table of Followers Pay.

Followers and Funds.	In Garrison.			In Camp.			
Cooks	0	8	0	1	0	0	Men in mess only.
Barber	0	4	0	0	5	4	In or out of mess.
Dhoby	0	12	0	0	10	8	In or out of mess.
Pipe Clay	0	1	0	0	1	0	Do.
Tin Fund	0	1	0	0	1	0	Men in mess only.
Total per mensem, Company's Rs..	1	10	0	2	2	0	

Broken periods of a month to be charged for Followers as follows.

If present from	1 to 5 days	No Stoppage.	
„	5 to 10 „	½	of pay of Followers.
„	10 to 15 „	½	„ „
„	15 to 20 „	⅔	„ „
„	20 to 25 „	¾	„ „
„	25 to 31 „	full stoppage.	

European Foot Artillery and Infantry Articles.	Number of each constituting.		
	Field Kit.	Reserve Kit.	Total of Field Kit.
Chaco	0	1	1
Forage Cap	1	0	1
Coatee	0	1	1
Undress Jacket Cloth	1	0	1
Woollen Trowsers, pairs	1	0	1
Great Coat	1	0	1
White Trowsers, pairs	0	4	4
Banyan do. do.	2	0	2
Serge do. do.	2	0	2
White Shirts	0	6	6
Banyan „	2	0	2
Flannel Waistcoats	2	0	2
White Jackets	0	2	2
„ Chaco Covers	0	2	2
„ Forage Cap Covers	1	1	2
Socks (2 pairs worsted, 2 cotton,)	2	2	4
Braces (1 Pair white for white clothing)	1	1	2
Towels	1	1	2

European Foot Artillery and Infantry Articles.	Number of each constituting.		
	Field Kit.	Reserve Kit.	Total of Field Kit.
Holdall containing	1	0	1
Button Stick and Brush	1	0	1
Knife, Fork and Spoon	1	0	1
Hair Comb and small tooth Comb	1	0	1
Hair Brush	1	0	1
Razor, Soap Brush, and Soap	1	0	1
Needles, Thread, thimble, buttons &c.	due portion.	0	due portion.
Clothes Brush	0	1	1
Shoe do,	0	2	2
Spunge	1	0	1
Boots, pairs	2	0	2
Marking Stamp	0	1	1
Haversack	1	0	1
Mess Tin and Cover with Strap	1	0	1
Regimental Carpet	1	0	1
Quilt	1	0	1
Account Book	1	0	1
Bible and Prayer Book	1	0	1
Pack Cloth	1	0	1
„ Slings	1	0	1
Field Valise	1	0	1

The above allotments of Articles constituting the "Field" and "Reserve" Kits are intended for ordinary occasions. The proportions can be varied under varying circumstances, at the discretion of the Commanding Officers.

Lascars and Drivers.

	Regimental Jacket.	Cloth Trousers.	„	Turbands.	Tape and Rosettes.	White Turband Covers.	Cloak.	Carpet.	White Jacket Ungreka with Collars.	White Trowsers.	Black „	Pair Native Short Cotton Drawers or other garment, To be worn under Cloth Trowsers.	Looonga,	Dupatta.	Kerchief or Skull Cap.	Brush.	Sandals or Shoes.	Jumbo and Rope.	Dishes with Straps.	Haversack.	Needles and Thread.
Field Kit	1	1		1	..	1	1	1	2	..	1	1	1	..	1	..	1	1	3	1	a due portion.
Reserve Kit	..	..		..	1	1	..	..	1	1	1	..	..	1	..	1	..	..	..	..	
Total or full kit	1	1		1	1	2	1	1	3	1	2	1	1	1	1	1	1	1	3	1	

The Gun Lascars and Drivers will continue to wear their knapsack as hitherto.

SCALE OF PAY OF NATIVE COMMISSIONED AND NON-COMMISSIONED RANK AND FILE, GOLUNDAUZE.

	Entertained prior to 1st May 1837.						Entertained subsequent to 1st May 1837.					
	Pay.			Batta.			Pay.			Batta.		
Subadars.. 1st Class after 10 Years Service	0	0	0	0	0	0	70	0	0	14	3	3
Subadars.. 2d " after 6 " "	0	0	0	0	0	0	52	8	0	14	3	3
Subadars.. 3d " under 6 " "	0	0	0	0	0	0	42	0	0	14	3	3
Jemadars	28	0	0	7	8	0	24	8	0	7	8	0
Havildars	14	0	0	5	0	0	14	0	0	5	0	0
Buglers	11	0	0	5	0	0	11	0	0	5	0	0
Naigues	12	0	0	5	0	0	12	0	0	5	0	0
Privates	8	4	0	2	5	10	7	0	0	1	8	0
Puckallies	10	11	10	1	14	5	10	11	10	1	8	0
Recruit Boys	0	0	0	0	0	0	3	8	0	0	0	0
Pension Boys	0	0	0	0	0	0	3	8	0	0	0	0

Gun Lascars and Artificers.

Same as attached to Companies of European Foot Artillery.

Regimental Necessaries.

	Regimental Jacket.	Cloak or Great Coat.	Woollen Trowsers prs.	Undress Jacket.	White Trowsers pairs.	Regimental Carpet.	Haversack.	Knapsack with Slings.	Banyan Trowsers.	Button stick and Brush.	Clothes Brush.	Stamps.	Turbands.	Tape and Rosettes.	White Jacket or Ungrekas.	Collars.	Loonga or Dhotie.	Duputta.	Kerchiefs.	Slippers pairs.	Braces pairs.	Jumboo and Ropes.	Dishes.	White Turband Covers.
Kit	1	1	1	1	2	1	1	1	2	1	1	1	1	2	3	3	2	2	2	2	2	1	3	2
Carried in Knapsack	0	*1	0	0	1	*1	0	0	2	1	1	1	0	1	2	2	1	1	1	0	0	0	3	1

* To be placed above the Kit inside the Knapsack and the flap of the Knapsack over them.

SCALE OF PAY OF A HORSE FIELD BATTERY.

	Pay.			Batta.		
Staff Serjeant (European)	33	15	5	0	0	0
Farriers .. 1st Class or after 17 Years Service	18	13	10	4	10	10
Farriers .. 2d „ or under 17 „ „	16	10	4	4	10	10
Havildars	12	0	0	3	8	10
Naigues	8	6	8	1	8	0
Drivers	7	0	0	1	8	0
Puckally	10	11	10	1	8	0
Recruit Boys	3	8	0	0	0	0
Horsekeeper Choudry	8	12	0	1	8	0
Horsekeepers	5	4	0	1	8	0
Grass Cutter Choudry	8	12	0	1	8	0
Grass Cutters	4	0	0	1	8	0
Moochy	7	9	9	1	8	0

Regimental Necessaries.

1	Cloth overalls, pairs.
1	Regimental Jacket.
1	Cloak.
2	Black Trowsers, pairs.
2	Stable Drawers.
3	White Jackets or Ungrekas.
4	White Caps.
3	White Collars.
1	Turband.
2	White do. covers.
1	Regimental Carpet.
1	Haversack.
1	Boots, pair,
1	Spurs, pair.
1	Slippers, pair.
1	Braces, pair.
1	Button Stick and Brush.
1	Clothes Brush.
1	Stamp.
a due portion.	Pipeclay, Needles and Thread.
1	Jumbo and Rope.
3	Dishes.

The following four pages have been compiled for the convenience of Light Field Batteries, and can be removed from the book, for detached guns on service if required.

EUROPEAN FOOT ARTILLERY BATTERY.

2-24 Pounder Howitzers 4-9 Pounder Guns.

Nature of Ordnance.	Weight of Gun or Howr. cwt.	qrs.	lbs.	Carriage cwt.	qrs.	lbs.	Limber. cwt.	qrs.	lbs.	Total. cwt.	qrs.	lbs.	Length of Howr. or Gun. feet.	Bore. Ins.	Chamber. Ins.	Diameter of Chamber Bore. Ins.	Chamber Superior. Ins.	Chamber Inferior. Ins.	Ganges. High. Ins.	Low. Ins.
24 Pdr. Howr.	10	...	...	12	...	...	10	...	...	32	...	...	4	46·5	5·47	5·66	5·66	4·25	5·62	5·57
9 ,, Gun	10	...	...	10	3	16	10	...	...	30	3	16	5-8½	65·75	...	4·2	.....	.....	4·1	4·08

Nature of Ordnance.	Canister 4oz. Balls. No.	Total Weight. lbs.	Sphl. Case. Thickness. ins.	Musket Balls. No.	Weight empty. lbs.	Do. Filled. lbs.	Common Shells and Shot. Diameter. ins.	Weight. lb.	Do. filled. lb	Thickness. in	Gunpowder. Proof of Ordnance. lb	Carriage. lb	Bouched Ordnance. lbs.	Service Charge. lbs.	Bursting C. Shell. oz.	Do. S. C. Shot oz	Exercise and Salutes. lbs.	Starting Fuzes oz	Scaling. oz
24 pr. How.	60	16⅞	·6	130	11	20⅜	5·595	16½	17	85	3	2	2	2	10	6	1⅛	1½	8
9 ,, Gun	40	11	·4	41	4½	7¾	4·1	0	0	0	2	2½	2½	2½	0	3½	1⅛	0	8

Nature of Ordnance.	Diameter of Vent. ins.	Unserve. Bore. ins.	Shell or Shot. ins.	Preponderance of Breech. lbs.	Windage. ins.	Tangent of 1° ins.
24 pr. How		5·70	7·54	99	·065	·837
9 ,, Gun		4·24	4·	88	·1	1·196

* In each of the hind boxes of Ammunition Waggons a Carcass is carried in lieu of a Shell. The priming powder in the near box of Gun Limber is carried in the priming pouch instead of a Cartridge. An empty priming pouch is carried in each of the other Limber boxes.

† Carried on the lid of each box.

Stowing Ammunition.

Nature of Ammunition.	24 Pr. How. No. in each Box.	No. in Axle Box.	Total for one Subdivision.	9 Pr. Gun. No. in each Ammunition Box.	No. in Axle Box.	Total for one Subdivision.
Shells Common	*4	0	*32	0	0	0
Shot Round	0	0	0	11	0	88
,, S. Case	5	0	40	3	0	24
,, Canister	1	2	10	2	0	16
Total	10	2	82	16	0	128
Cartridges filled	11	0	88	18	0	144
,, Empty	1	0	8	2	0	16
,, Priming	1	0	8	1	0	8
,, Burst. C.S.	*4	0	*32	0	0	0
,, S.C Shot.	5	0	40	3	0	24
Portfires	12	0	24	14	0	32

Common Shells 24 Pdr.			Round Shot 9 Pdr.	
Range.	Elev.	Fuze.	Range.	Elev.
yards.	deg.	ths.	yards.	deg.
250	P B.	..	300	P.B.
300	¼	..	400	½
350	½	..	500	¾
400	¾	1	600	1
450	1	1½	700	1
500	1¼	2	775	1¼
550	1½	2½	850	1½
600	1¾	3	925	1¾
650	2	3½	1000	2
700	2¼	4	1050	2¼
750	2½	4½	1100	2½
800	2¾	5	1150	2¾
850	3	5½	1200	3
900	3¼	6	1250	3¼
950	3½	6½	1300	3½
1000	3¾	7	1350	3¾
1025	4	7½	1400	4
1050	4¼	7½	....	..
1075	4½	7¾	....	..

Spherical Case Shot.				
	24 Howr.		9 Pr. Gun	
Range.	Elev.	Fuze.	Elev.	Fuze.
yards.	deg.	ins.	deg.	ins.
600	1¾	·3	1½	·3½
700	2¼	·4	1¾	·3¾
800	2¾	·5	2	·4
900	3¼	·6	2¼	·4½
1000	3¾	·7	2½	·5½
1100	4½	·8½	2¾	·6½
1200	5¼	·9½	3¼	·7½
1300	6¼	1·	4	·8½
1400	7¼	1·1	5	·9½
1500	8	1·2	5¾	1·0½
1600	8¾	1·3	6¾	1·1½
1700	9½	1·4	7½	1·3

Ricochet.				
	24 Howr		9 Pr. Gun	
Range.	Charge	Elev.	Charge	Elev.
yards.	oz.	deg.	oz.	deg.
300	16	2	9	2
„	8	6½	..	..
350	..	..	9¼	2½
400	9	7	6	4½
„	11	6	10	3
„	16	3	..	..
450	..	..	7	4½
500	11¾	7	6	6½
„	9	8½	..	..
„	16	4½	..	..
550	11½	8	6	7½
600	14	8	11	4
„	16	5¾	..	..

Canister 24 Pdr. Howr. and 9 Pdr. Gun.	
Range.	Elevation.
yards.	Degrees.
150	P. B.
200	¼
250	½
300	¾
350	1
400	1½

Carried on the Gun Carriage.	
Axe hand with Helve	1
Bit Gun Steel small	1
Bucket Water	1
Chain Locking	1
Drift Vent Gun	1
Hammer with Turnscrew	1
Iron Priming	1
Rock Portfire	1
Sponges with Canvas Caps	2

STORES BELONGING TO 1 SUB-DIVISION.

Carried in Gun Limber Small Store Box.	
Auger Fuze Brace	1
Bottle Copper with 6 ozs. of Spirits of Wine	1
Box with 30 Spherical Case Fuzes	1
„ with half skein of Quick Match	1
„ Copper dredging with ½ lb. of Mealed Powder	1
Cloth, Waxed.....yards.	4
Compasses Common, pairs.	1
„ Brass, pocket, Gunner's	1
Esses Iron	4
File Saw	1
Funnel Copper small	1
Hammer Wrench	1
Knife Laboratory	1
Mallet Setting	1
Match Cotton Skein	1
Pincers Fuze Brass	1
„ Gun	1
Rasp half round	1
Saw Fuze	1
Setters steel for Saws	1
Scale Gunter 2 feet Brass	1
Scissors, pairs	1
Setter Fuze	1
Spike Gun Ragged	1
„ „ Spring	1
Twine Europe fine.....lbs.	1
Vices Hand Fuze wooden	1
Wrench Iron, for nuts screw	1
Worms for Spunges	1

Carried on Limbers.	
Box Grease, to each Limber	1
Prolong	1

Carried on the Ammunition Waggon.	
Axe Felling	1
Axe Pick	1
Axletree Iron, to a Battery.	2
Bucket Water	1
Chain Locking	1
Crowbar	1
Handspike Common	1
Mamoties	2
Prop Wheel	1
Ropes Drag, Gun L. F.	2
Wheels, spare, to a Battery.	2

HORSE ARTILLERY AND GOLUNDAUZE BATTERY.

2-12 Pounder Howitzers — 4-6 Pounder Guns.

Nature of Ordnance.	Weight of Gun or Howr. cwt.	qrs.	lbs.	Carriage cwt.	qrs.	lbs.	Limber. cwt.	qrs.	lbs.	Total. cwt.	qrs.	lbs.	Length of Howr. or Gun. feet.	Bore. Ins.	Chamber. Ins.	Diameter of Bore. Ins.	Chamber Superior. Ins.	Chamber Inferior. Ins.	Gauges. High. Ins.	Low. Ins.
12 Pdr. Howr.	6	2	...	10	2	12	10	...	...	27	...	...	12	3-94	44·	6·8	4·52	4·52	3·4	4·476	4·432
6 ,, Gun	6	...	...	9	2	18	10	...	...	25	2	18	5	57·47	...		3·668	.....	.....	3·568	3·533

Nature of Ordnance.	Canister 4 oz. Balls. No.	Canister Total Weight. lbs.	Sphl. Case. Thickness. ins.	Sphl. Case. Musket Balls. No.	Sphl. Case. Weight empty. lbs.	Sphl. Case. Do. Filled. lbs.	Common Shells and Shot. Diameter. ins.	Common Shells and Shot. Weight empty. lb.	Common Shells and Shot. Do. filled. lb	in	Common Shells and Shot. Thickness.	Gunpowder. Proof of Ordnance. lb	Carriage. lbs.	Bouched Ordnance. lbs.	Service Charge. lbs.	Bursting C. Shell. oz.	Do. S. C. Shot. oz	Exercise and Salutes. lbs.	Starting Fuzes oz	Sealing. oz
12 pr. How	37	10 8¼	·45	63	5-12	10-6	4·454	8 3/16	8½		·7	1⅛	1½	1½	1½	5	4½	1	1	4
6 ,, Gun	25	7	·3	27	3	5	3·567	0	...	0		2	1¼	1½	1½	0	2½	1¼	0	4

Nature of Ordnance.	Diameter of Vent. ins.	Diameter of Unserve. Bore. ins.	Diameter of Unserve. Shell or Shot. ins.	Preponderance of Breech. lbs.	Windage. ins.	Tangent of 1°. ins.
12 pr. How	0·56	4·56	4·40	46	·066	·789
6 ,, Gun	0·56	3·708	3·49	56	·101	1·047

Stowing Ammunition.

Nature of Ammunition.	12 Pr. How. No. in each Box.	12 Pr. How. No. in Axle Box.	12 Pr. How. Total for one Subdivision.	6 Pr. Gun. No. in each Ammunition Box.	6 Pr. Gun. No. in Axle Box.	6 Pr. Gun. Total for one Subdivision.
Shells Common.....	*8	0	*64	0	0	0
Shot Round.....	0	0	0	18	0	144
,, S. Case.....	8	0	64	4	0	32
,, Canister.....	1	0	8	2	2	18
Total...	17	0	136	24	2	194
Cartridges filled.....	18	0	144	26	0	208
,, Empty	2	0	16	2	0	16
,, Priming	1	0	8	1	0	8
,, Burst. C. S.	*8	0	*64	0	0	0
,, S. C. Shot.	8	0	64	4	0	32
Portfires	†4	0	32	†5	0	40

* In each of the hind boxes of Ammunition Waggons, 2 Carcasses are carried in lieu of an equal number of Shells. The priming powder in the near box of Gun Limber is carried in the priming pouch instead of a Cartridge. An empty priming pouch is carried in each of the other Limber boxes.

† Carried on the lid of each box.

Common Shells 12 Pdr.			Round Shot 6 Pdr.	
Range.	Elev.	Fuze.	Range.	Elev.
yards.	deg.	ths.	yards.	deg.
200	P.B.	..	200	P.B.
250	¼	..	300	¾
300	½	..	400	1¼
350	¾	..	500	1¾
400	1	1½	600	2
450	1¼	1¾	650	2¼
500	1½	2¼	700	2½
550	1¾	2¾	750	2¾
600	2	3¼	800	3
650	2¼	3¾	850	3¼
700	2½	4¼	900	3½
750	2¾	4¾	950	3¾
800	3	5¼	1000	4
850	3¼	5¾	1050	4¼
900	3½	6¼	1100	4½
950	3¾	6¾	1150	4¾
1000	4	7¼	1200	5
1025	4¼	7½	....	..
1050	4½	7¾	....	..

Spherical Case Shot. 12 Howr. 6 Pr. Gun				
Range.	12 Howr. Elev.	12 Howr. Fuze.	6 Pr. Gun Elev.	6 Pr. Gun Fuze.
yards.	deg.	ins.	deg.	ins.
600	2	·3	1½	·2¾
700	2¼	·4	1¾	·3½
800	3	·5¼	2¼	·4¼
900	3¼	·6¼	2¾	·5
1000	4	·7¼	3	·6
1100	5	·8¾	3¾	·7
1200	6	1·	4¼	·8
1300	7	1·1¼	5	·9
1400	8¼	1·3	5¾	1·0¼
1500	9	1·4¼	6¼	1·1¾
1600	9¾	1·6	7¼	1·2¾
1700	10¼	1·7¼	8¼	1·4

Ricochet. 12 Howr.		6 Pr. Gun	
Range.	Charge.	Elev.	Charge.	Elev.
yards.	oz.	deg.	oz.	deg.
300	5	5½	6	2
350	..	..	5	3¼
400	5	6¾	6	3¾
„	7½	5	..	..
„	10	3	..	..
450	6	6¾	6½	3¾
500	7	6	4	6
„	6	7½	7	3½
550	8	6	4	7
„	..	..	8	3
600	8	7	8	4
„	10	5½	..	..

Canister 12 Pdr. Howr. and 6 Pdr. Gun.	
Range.	Elevation.
yards.	Degrees.
100	P. B.
150	¼
	½
	¾
300	1
350	1¼

Carried on the Gun Carriage.

- Axe hand with Helve 1
- Gun Steel small 1
- Bucket Water 1
- Chain Locking 1
- Deft Vent Gun 1
- Hammer with Turnscrew 1
- Iron Priming 1
- Stock Portfire 1
- *Sponges* with Canvas Caps ... 2

STORES BELONGING TO 1 SUB-DIVISION.

Carried in Gun Limber Small Store Box.

- Auger Fuze Brace 1
- Bottle Copper with 6 ozs. of Spirits of Wine 1
- Box with 7 Spherical Case Fuzes 1
- „ with half skein of Quick Match 1
- „ Copper dredging with ½ lb. of Mealed Powder 1
- Cloth, Waxed ..... yards 4
- Compasses Common, pairs. 1
- „ Brass, pocket, Gunner's 1
- Esses Iron 4
- File Saw 1
- Funnel Copper small 1
- Hammer Wrench 1
- Knife Laboratory 1
- Mallet Setting 1
- Match Cotton ..... Skein 1
- Pincers Fuze Brass 1
- „ Gun 1
- Rasp half rounds 1
- Saw Fuze 1
- Setters steel for Saws 1
- Scale Gunter 2 feet Brass 1
- Scissors ..... pairs 1
- Setter Fuze 1
- Spike Gun Ragged 1
- „ „ Spring 1
- Twine Europe fine ..... lbs. 1
- Vices Hand Fuze wooden ... 1
- Wrench Iron, for nuts screw 1
- Worms for Sponges 1

Carried on Limbers.

- Box Grease, to each Limber 1
- Sheeting 1

Carried on the Ammunition Waggon.

- Axe Felling 1
- Axe Pick 1
- Axletree Iron, to a Battery .. 2
- Bucket Water 1
- Chain Locking 1
- Crowbar 1
- Handspike Common 1
- Mamoties 2
- Prop Wheel 1
- Ropes Drag; Gun L. F. 2
- Wheels, spare, to a Battery. 2

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